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ANNALS OF AGRICULTURAL RESEARCH

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EFFECT OF CROPPING SYSTEMS, FERTILITY LEVELS AND MOISTURE CONSERVATION PRACTICES ON GROWTH AND YIELD OF PEARLMILLET AND MOTHBEAN IN INTERCROPPING SYSTEM

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ABSTRACT

A field experiment on moisture conservation and nutrient management studies in sole and intercropped pearlmillet under rainfed conditions was conducted during two consecutive *kharif* seasons of 2003 and 2004. The treatment combination comprised two cropping systems and three fertility levels in main plots and four moisture conservation practices. The results indicated that planting of one row of mothbean in between paired rows (30/70cm) of pearlmillet was superior over sole pearlmillet in respect of pearlmillet equivalent yield. Application of 40 kg N + 20 kg P_2O_5/ha recorded higher growth and yield of pearlmillet under both sole and intercropping system as well as that of mothbean. Application of FYM @ 5t/ha + dust mulch + straw mulch was found the best moisture conservation practice by recording higher growth and yield of pearlmillet as well as mothbean over rest of the moisture conservation practices.

Key words : Pearlmillet, mothbean, intercropping, fertility levels, mulch.

Pearlmillet (*Pennisetum glaucum*) It is the staple food for millions of people in the poor soils of semi-arid tropics. Pearlmillet survives in rainfed areas because of its drought escaping mechanism but still responds well to all inputs including fertilizer doses.

The soil moisture is the most important factor of successfull crop production in dryland areas. Use of organic manure as well as mid season corrections through mulches, anti transpirants and planning methods are effective in increasing productivity and water use by pearlmillet under rainfed conditions.

MATERIALS AND METHODS

A field experiment was conducted on a sandy loam soil of the Research Farm of the Division of Agronomy, Indian Agricultural Research Institute, New Delhi during *kharif* of 2003 and 2004. This location has a typical semi-arid and sub-tropical climate characterized by hot dry summer and cool winter. The rainfall received during the growing period from June to October was 810.3 mm in 2003 and 425.4 mm in 2004. The experiment was laid out in split-plot design with three replications. The treatments combinations comprised two cropping systems [pearlmillet sole (50 cm row spacing and pearlmillet paired row (30/70 cm row spacing) + one row of mothbean] and three fertility levels (control, 40 kg N + 20 kg P_2O_5/ha and 80 kg N + 40 kg P_2O_5/ha) in main plots and four moisture conservation practices (no mulch, dust mulch + straw mulch, kaolin + straw mulch and FYM @ 5t/ha + dust mulch + straw mulch) in subplots.

Full dose of nitrogen and phosphorus as per treatments through urea and SSP, respectively were applied just before sowing of crops. The placement was done through an iron pipe (pora) attached to the bullock drawn country plough. FYM was incorporated in the plots after preparing layout as per treatments in both the years. Pusa 605 and RMO-40 varieties of pearlmillet and mothbean, respectively were used for experimental purpose. Sowing of the crops was done on 15 July in 2003 and 31 July in 2004. The pearlmillet seeds were sown @ 5 kg/ha by dropping the seeds in furrow behind the plough. The seed rate of mothbean was decided according to space available for intercropping in pearlmillet. The spacing between rows in sole pearlmillet was maintained at 50 cm while, the paired row sowing was done at a distance of 30 cm apart and distance between two pairs of rows was 70 cm. One row of mothbean was sown in between two paired rows of pearlmillet. After sowing, light planking was done immediately to cover the seeds. The first dust mulch was created at 25 DAS and second was at 40 DAS in both the years. The wheat straw @ 5t/ha was spread over the soil surface at 42 DAS according to treatments. Kaolin (6% suspension) was sprayed as per treatments over the crop foliage at 50 DAS in both the years. Plants from the net plot area were harvested from the ground level and were left for sun drying *in-situ*. Pearlmillet mothbean were threshed manually. Grains were cleaned and weighed for expressing yield in q/ha. The weight of stover was recorded separately and used for estimating stover yield.

RESULTS AND DISCUSSION

Pearlmillet

The cropping systems had no effect on the plant height, number of tillers, dry matter accumulation, LAI and days to 50 per cent flowering of pearlmillet at various crop growth stages. Application of 80 kg N + 40 kg P_2O_5/ha significantly improved all the growth attributes of crop over control. It might be attributed due to the role of nitrogen and phosphorus in a number of functions related to growth, development, phytosynthesis and utilization of carbohydrates. The work of Yakadri and Gautam (2001) and Tetarwal (2001) corroborates the above finding. FYM @ 5t/ha + dust mulch + straw mulch recorded the higher growth components as compared to other moisture conservation practices. This could be attributed to an extended period of moisture availability, improved soil physical properties, hydraulic conductivity as well as availability of NPK due to FYM and mulching. Similar results were also reported by Jat and Gautam (2000).

Cropping system had non significant effect on yield attributes. The application of 80 kg N + 40 kg P_2O_5/ha being on par with 40 kg N + 20 kg P_2O_5/ha, recorded significantly higher values of yield attributes compared to control. The favourable improvement in yield attributes could be assigned from favourable influence of nitrogen and phosphorus nutrition on the growth parameters. The observations of the present study are in line with the findings of Bhagchand and Gautam (2000). FYM @ 5t/ha + dust mulch + straw mulch recorded the highest values growth characters followed by kaoin + straw mulch, dust mulch + straw mulch and lowest with no mulch. This could be assigned due to the combined effect of these components in more effectively reducing the evaportanspiration losses and increasing water holding capacity of soil (Kaushik and Lal, 1997).

Cropping system did not influence the grain and stover yield as well as harvest index of pearlmillet. This might be due to the fact that change in planting system did not vary grain and stover yield of pearlmilet at a constant level of plant population. Similar results were also reported by Goswami *et al.,* (2002).

Application of 80 kg N + 40 kg P_2O_5/ha recorded significantly higher grain yield over control. The reason is obviously the availability of more amounts of N and P nutrients for better growth and development which ultimately resulted in higher yield. Among the various moisture conservation practices FYM @ 5t/ha + dust mulch + straw mulch recorded significantly higher yield followed by kaolin + straw mulch dust mulch + straw mulch. The increased productivity of grain and stover with moisture conservation practices was due to its favourable effects on growth and yield attributes as described earlier. Similar results in pearlmillet have been reported by Jat and Gautam (2001).

Mothbean

The application of 80 kg N + 40 kg P_2O_5/ha significantly influenced the growth attributes *viz.*, plant height, dry matter production, LAI and number of branches/ plant of mothbean (Table 1) as compared to no fertilization. Maximum values of growth attributing characters were recorded under FYM @ 5t/ha + dust mulch + straw mulch and minimum with no mulch. This might be due to reduction in evaportanspirational losses of water,

Table 1. Effect of cropping system, fertility levels and moisture conservation practices on growth parameters at harvest, yield attributies and yield

Treatment	Plant height (cm)	No. of tillers/m row length	Dry matter accumulation (g/plant)	LAI	Days to 50% flowering	No. of ear-head/m	Length of ear-head (cm)	Girth of ear-head (cm)	100-grain weiht (g)	Grain yield (q/ha)	Stover yield (q/ha)	Pearlmiilet equivalent yield (q/ha)
Cropping system												
Pearlmillet sole (50 cm row) spacing)	164.7	19.5	49.5	1.2	46.2	13.68	25.81	7.81	6.68	26.60	73.74	26.60
Pearlmillet paired row (30/70) + one row of mothbean	167.1	18.7	48.0	1.1	44.0	13.21	25.20	7.69	6.54	25.39	69.72	29.60
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1.66
Fertility levels												
Control	151.5	15.1	40.6	0.8	40.6	10.01	21.43	7.33	6.46	21.80	54.97	23.14
40 kg N + 20 kg P_2O_5/ha	170.2	20.6	51.8	1.3	46.8	14.87	27.03	7.90	6.66	27.37	77.45	29.78
80 kg N + 40 kg P_2O_5/ha	176.0	21.7	54.3	1.3	47.9	15.46	28.06	8.02	6.72	28.81	82.78	31.40
CD (P=0.05)	6.69	1.75	2.71	0.08	2.99	0.82	1.27	0.32	NS	2.00	6.34	2.03
Moisture conservation practices												
No mulch	152.8	15.5	41.9	0.9	41.1	10.27	22.43	7.1	6.43	20.76	55.93	22.08
Dust mulch + straw mulch	163.0	18.9	48.0	1.1	44.7	13.19	24.84	7.76	6.58	25.94	69.77	28.09
Kaolin + straw mulch	167.2	19.5	49.7	1.2	45.3	14.08	25.78	7.78	6.64	27.11	74.69	29.36
FYM @ 5t/ha + dust mulch + straw mulch	180.6	22.6	55.3	1.3	49.3	16.24	28.98	8.37	6.80	30.17	86.51	32.89
CD (P=0.05)	9.14	1.91	4.61	0.12	3.07	1.13	1.64	0.65	NS	2.35	7.11	2.38

Table 2. Effect of fertility levels and moisture consrvation practices on growth parameters at harvest, yield attributies and yield of moth bean in pearlmillet - moth bean intercropping system (Mean of two years)

Treatment	Plant height (cm)	Dry matter accumulation (g/plant)	LAI	No. of branches/ plant	No. of pods/ plant	No. of grains/ pod	Grain weight/ pod(g)	1000-grain weight (g)	Grain yield (q/ha)	Stover yield (q/ha)
Fertility levels										
Control	23.17	8.51	1.65	3.80	19.10	4.35	0.09	27.47	0.85	2.20
40 kg N + 20 kg P_2O_5/ha	27.44	10.38	1.85	4.83	22.68	5.28	0.14	28.27	1.54	3.86
80 kg N + 40 kg P_2O_5/ha	28.55	10.79	1.89	5.04	23.58	5.52	0.15	28.22	1.67	4.10
CD (P=0.05)	1.62	1.06	0.17	0.31	2.27	0.33	0.01	NS	0.20	0.51
Moisture conservation practices										
No mulch	22.81	8.38	1.61	3.88	10.02	4.34	0.10	27.59	0.85	2.13
Dust mulch + straw mulch	26.33	9.93	1.80	4.54	21.9	5.05	0.12	28.04	1.38	3.46
Kaolin + straw mulch	26.65	10.00	1.80	4.62	22.01	5.09	0.13	28.13	1.44	3.61
FYM @ 5t/ha + dust mulch + straw mulch	29.74	11.24	1.93	5.19	24.21	5.70	0.14	28.19	1.74	4.35
CD (P=0.05)	2.77	1.09	0.16	0.29	1.90	0.49	0.01	NS	0.29	0.42

suppression of weeds and conserve soil moisture, which ultimately leads to extended period of water availability during crop season. Application of fertility levels enhanced the yield attributes viz., number of pods/plant, number of grains/pod, grain weight/pod and 1000-grain weight (Table 2) of mothbean.

Moisture conservation practices too produced improvement in the yield attributing characters viz., number of pods/plant, number of grains/pod and grain weight/pod of mothbean but failed to produce marked influence on 1000-grain weight.

Application of 80 kg N + 40 kg P_2O_5/ha being on par with 40 kg N + 20 kg P_2O_5/ha, produced significantly higher grain yields than control. Nitrogen and phosphorus fertilization enhanced the number of pods/plant, number of grains/pod and grain weight/pod remarkably over control which in turn resulted in perceptible improvements in grain and stover yield. Moisture conservation practives increased significantly the grain and stover yield of mothbean. The highest values were associated with FYM @ 5 t/ha + dust mulch + straw mulch and the next best treatments were kaolin + straw mulch and dust mulch + straw mulch being at par with each other. The increased productivity of mothbean due to these treatments apparently resulted from their favourable effect on various growth and yield components.

Pearlmillet equivalent yield

Cropping systems exhibited significant improvement in pearlmillet equivalent yield. Pearlmillet intercropped with mothbean recorded significantly higher perlmillet equivalent yield as compared to sole pearlmillet. The higher pearlmillet equivalent yield intercropping treatment was due to additional yield of mothbean and its higher price in the market. The results are in accordance with the findings of Tetarwal and Nanwal (2002).

Application of 80 kg N + 40 kg P_2O_5/ha recorded significantly higher pearlmillet equivalent yield. This might be attributed to increase in economic yield of both the component crops with nitrogen and phosphorus application. Corroborative findings have been reported by Bhagchand and Gautam (2002).The maximum pearlmillet equivalent yield was recorded with FYM @ 5t/ha + dust mulch + straw mulch followed by kaolin + straw mulch, dust mulch + straw mulch and minimum with no mulch. It might be due to the fact that significant increase in grain yield of pearlmillet coupled with increased yield of mothbean in moisture conservation treatments over no mulch resulted in higher pearlmillet grain equivalent yield.

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BIOLOGICAL MANAGEMENT OF WILT OF BRINJAL

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ABSTRACT

Biocontrol potential of *Trichoderma viride, T. harzianum, T. longibrachiatum, T. pseudokoningi* and *Gliocladium virens* was evaluated against wilt of brinjal (*Fusarium oxysporum*) under pot house conditions. All the biocontrol agents significantly improved germination percentage over inoculated control. Seed treatment with *T. viride* recorded the highest seed germination and soil incorporation of neem cake further improved its efficacy along with improvement in plant length and weight. This was followed by *T. harzianum, T. longibrachiatum, T. pseudokoningi* and *G. virens.*

Key words : Wilt of brinjal, *Trichoderma viride, T. harzianum, T. longibrachiatum, T. pseudokoningi, Gliocladium virens.*

Vegetables are important cash crop in Andaman and Nicobar islands. Because of limited availability of agricultural land, vegetable cultivation requires much more care and attention than other food crops. Brinjal is grown in almost all parts of Andaman but wilt disease caused by *Fusarium oxysporum* is a limiting factor in its cultivation. Farmers in routine resort to use of fungicides for its control. But use of agro chemicals not only causes environmental pollution but also exerts devastating effect on soil inhabiting beneficial micro organisms. Therefore, the present study was undertaken to evaluate the efficiency of biological control agents such as *Trichoderma viride, T. harzianum, T. longibrachiatum, T. pseudokoningi and Gliocladium virens* in association with neem cake amendment against wilt (*Fusarium oxysporum*) of brinjal.

MATERIALS AND METHODS

Earthen pots measuring about 30 cm in diameter were filled with 5 kgs. of autoclaved field soil and sterilized seed of brinjal were sown on January 3, 2003. After germination, thinning was done so as to maintain the number of pant one per pot. The pots were irrigated twice a day to maintain the requisite soil moisture level. The antagonistic fungi *T. viride, T. harzianum, T. longibrachiatum, T.pseudokoningi* and *Gliocladium virens,* obtained from Division of Plant Pathology, IARI, New Delhi and the locally isolated pathogen *F. oxysporum* were cultured on Potato Dextrose Agar (PDA) medium following standard Phytopathological techniques on incubator-cum-shaker maintained at 25 ±1° for 7 days. The resultant fungal mycelial mat was dried in an oven and then blended in a mixture to form a powder mass to be used for soil inoculation and seed treatment. The mycelial powder of the antagonistic fungi was applied to pot soil and then 4" thick soil was also added and then pathogen was added before sowing. In some pots along with mycelial powder of antagonistic fungi, neem cake @ 20 grams per pot was also added. The antagonists and the pathogen were applied to soil @ 5 gm mycelial powder per pot. In control pots, seeds were treated with carbendazim @ 2 g per seed before sowing.

The same mycelial powder of antagonist was used for treating brinjal seeds @ 2 g per kg. seed before sowing. All the treatments were replicated thrice. Observations on germination, plant length, plant height were recorded and data collected was analyzed employing completely randomized design (CRD). The experiment lasted for two and a half months.

RESULTS AND DISCUSSION

All the fungal biocontrol agents and neem amendment significantly improved germination

Table 1. Effect of biocontrol agents and neem amendment on plant growth

S.No.	Treatment	Germination (%)	Plant length			Plant weight		
			Shoot	Root	Total	Shoot	Root	Total
1.	*Trichoderma viride*	82.5	27.3	15.2	42.5	19.5	12.8	32.3
2.	*T. viride* + Neem amendment	87.8	28.2	15.8	44.0	20.1	13.3	33.4
3.	*T. harzianum*	79.3	26.9	15.0	41.9	19.2	12.6	31.8
4.	*T. harzianum* + Neem amendment	84.1	27.0	15.2	42.1	19.3	12.7	32.0
5.	*T. longibrachiatum*	78.2	28.1	15.7	43.8	20.0	13.2	33.2
6.	*T. longibrachiatum* + Neem amendment	83.8	28.9	16.1	45.0	20.6	13.6	34.2
7.	*T. pseudokoningi*	78.0	26.1	14.6	40.7	18.6	12.3	30.9
8.	*T. pseudokoningi* + Neem amendment	84.6	26.5	14.8	41.3	18.9	12.5	31.4
9.	*G. virens*	73.0	27.5	15.4	42.9	19.7	12.9	32.6
10.	*G. virens* + Neem amendment	78.2	28.1	15.7	43.8	20.0	13.6	33.6
11.	Neem cake	70.1	25.4	14.2	39.6	18.2	11.9	30.1
12.	Carbendazim	94.6	27.8	15.5	43.3	19.8	13.1	32.9
13.	Inoculated control	63.4	17.2	9.6	26.8	12.2	8.1	20.3
	C.D.(P = 0.05)	2.50			1.37			1.68

percentage over the inoculated control (Table 1). However, seed treatment with carbendazim registered the highest (94.6%) germination. Among the biocontrol agents, *T. viride* seed treatment recorded the highest seed germination. Soil incorporation of neem cake further improved seed germination along with improvement in plant length and weight (32.3 g). This was followed by seed treatment with *T. harzianium* (42.5 g)., *T. longibrachiatum* and *T. pseudokoningi*. Seed treatment with *G. virens* also significantly enhanced germination along with increase in plant length and weight as compared to inoculated control.

Incorporation of neem amendment to soil considerably increased efficiency of all the biocontrol agents. The improvement in plant growth parameters *viz.*, length and weight might be due to reduction in infection by biocontrol agents and anti microbial activity exerted by neem amendment.

Both *Trichoderma* spp. and *Gliocladium virens* are known potential antagonists of fungal plant pathogens (Papavizas, 1985). Biological seed treatment has been found to be an attractive as well as efficient method for introducing the antagonists into soil-plant environment. Sivan and Chet (1989) reported effectiveness of *T. harzianium* against *F. oxysporum*. Wani (2005) reported successful biological control of brinjal with *Trichoderma* spp. Sivan *et al.* (1987) reported successful management of Fusarium crown rots of tomato by *T. harzianium* application.

The role of composts as amendments for the control of soil borne plant pathogens is becoming increasingly popular. The anti-microbial property of various components of neem tree is widely established and published (Schmutterer, 1981; Hoitink and Peter, 1986). Gunasekaran *et al.* (1986) reported suppression of Thanjavur wilt of coconut by soil application of neem cake. Arya (2002) also reported significant reduction in flag smut of wheat by soil incorporation of neem cake.

The present studies suggest the synergistic effect exerted by neem cake amendment on the activity of fungal antagonists. It can play a significant role in increasing efficiency of biocontrol agents and reducing pesticides usage for disease management.

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EFFECT OF TIME, MEDIA AND ROOT INDUCING AUXINS ON THE ROOTING OF GUAVA (CV. ALLAHABAD SAFEDA) AIR-LAYERS UNDER HIGH RAINFALL ZONE OF KODAGU

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ABSTRACT

The present investigation was carried out to know the suitable time, optimum concentration of growth regulators and locally available media to get the rooting success in 12 years old guava air layers cv. Allahabad Safeda under high rainfall zone of Kodagu. Study revealed that 10,000 ppm (T_4) was best among all the treatments as far as rooting is concerned. July was the best month for making the air layers in guava cv. Allahabad Safeda. Among the media, through no significant difference was found in respect to rooting percentage while the coffee husk (M_3) gave the best result compared to other media used in the study.

Key words : Growth regulator, air layering, rooting, medium, Allahabad Safeda.

Guava (*Psidium guajava* L.) is one of the most important fruit crops and occupies fourth place in area and production in India. It is rich in Vitamin 'C', protein, carbohydrates, minerals and pectin ; hence widely used in preparation of jelly and jam. The are under this crop is steadily increasing in Kodagu district in Karnataka states as the crops thrive well. In view of this the demand for planting material is also on the increasing trend. Therefore, standardization of propagation techniques would facilitate area of expansion in this region.

Air layering in guava is one of the widely adapted techniques for its propagation as it is a cheaper, safer and more convenient method (Gandhi, 1954). Use of appropriate growth regulators, especially auxins in accordance with crop reguirement have made breakthrough in rooting of cuttings and air layers. Phenolic compounds more effective in synergism with auxins to induce rooting in relatively difficult to root fruit trees like mango, guava and litchi (Bose *et al.* 1972). Root inducing auxins such IBA and NAA increased the success of air layering by producing roots easily (Patel *et al.* 1996). Air layering carried out in the month of July along with IBA 10000 ppm gave the highest percentage of success and also promoted all the root characters (sharma *et al.* 1991). The success of air-layers depends on the use of optimum concentration of growth regulator, type of media and time of application (Sharma *et al.* 1975). Since, hardly report is available on guava air layering under high rainfall zone of Kodagu. The growth regulator and locally available media (in place of lanolene) to get the rooting success in guava cv. Allahabad Safeda air layers.

MATERIALS AND METHODS

Present investigation was carried out on 12 years old guava cv. Allahabad Safeda at Central Horticultural Experiment Station, Chettalli, Kodagu, Karnataka. Nine treatments (T_1-IBA 2500 ppm, T_2-IBA 5000 ppm, T_3-IBA 7500 ppm, T_4-IBA 1000 ppm, T_5-NAA 1000 ppm, T_6 -NAA 2000 ppm, T_7-NAA 3000 ppm, T_8-NAA 4000 ppm, T_9-Control), four locally available media (M_1-Saw dust, M_2-Rice brawn, M_3-Coffee husk and M_4-Coir pith) were used in three different months (July, August and September) during the year 2002. The experiment was tested under FRBD with three replications and ten shoots in each treatment.

Three-centimeter wide ring of bark was removed from the pencil thick shoots and slight scrapping of wood was done done to ensure complete removal of phloem and cambium to avoid healing of girdle. Locally available media soaked overnight in different concentration of IBA and NAA was placed around the upper portion of the cut. The control shoots were treated with only respective media soaked overnight in water. After waiting of 3-5 minutes 3-5 minutes the cut portions were covered with moist sphagnum moss and both the ends were tied with gunny twines after layers were detached from mother plants. The observations were recorded on percentage of rooting and root characters.

RESULTS AND DISCUSSION

Percentage of rooting

Among months of air layering, the percentage of rooting was significantly higher when air layering was done during July month (52.60%) followed by August (39.50%) and September (20.02%) Table 1. This clearly exhibits a declining trend in percent rooting from July month onwards. The differences in rooting percentage may be attributed to the varying weather conditions viz., temperature, relative humidity and rainfall. During July relatively low temperature, high relative humidity and rainfall provided the conducive environment for the root initiation. This result is also in conformity with the results of Ahmad (1964) who advocated that rainy season is good for air layering.

The effect of auxin concentrations on percentage of rooting was significant during all the months. It was found maximum in treatment T4 received IBA 10,000 ppm (47.12%) which was at par with treatment T_1 (46.76%), T_5 (42.33%) and T_2 (41.93%), however significantly higher in respect to the remaining treatments. This is in conformity with the result of Kumar and Khanna (1987) and Sharma *et al.* (1991), they advocated that use of 10,000 ppm IBA gives higher percentage of rooting in Mango and Guava air-layers, respectively. Among two growth regulators used in this study ; IBA gave better results when compared with NAA with respect to all root characters. Similar results were obtained by Chandrappa and Gowda (1998) in guava The better effect of IBA could be due to non-prone to photo oxidation unlike, NAA as

Table 1. Effect of time, media and growth regulators on rooting percentage of guaga (cv. Allahabad Safeda) air-layers

Treat.	July					August					September					Overall Mean
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	
T_1	81.15	83.85	81.15	83.85	82.50	64.22	51.15	54.99	51.93	55.57	00.00	00.00	00.00	08.85	55.57	46.76
T_2	77.71	77.71	75.00	70.78	75.30	63.85	38.07	30.78	33.85	41.64	08.85	08.85	08.85	08.85	41.64	41.93
T_3	47.01	55.08	75.00	53.15	57.56	59.22	35.01	51.15	59.22	51.15	00.00	08.85	00.00	17.71	51.15	38.45
T_4	68.85	77.71	72.78	72.29	72.91	43.08	41.07	54.99	51.15	47.57	21.93	21.93	21.93	17.71	47.57	47.12
T_5	21.93	42.99	54.99	54.99	43.73	51.15	30.00	38.85	30.78	37.70	28.78	51.15	51.15	51.15	37.70	42.33
T_6	34.63	21.15	43.08	24.15	31.50	28.08	21.83	38.85	33.00	30.47	45.00	36.15	16.92	51.15	30.47	33.09
T_7	43.08	38.85	23.85	43.08	37.22	36.93	26.56	63.85	21.15	37.12	11.07	51.15	38.85	38.85	37.12	36.44
T_8	21.93	30.78	30.78	30.00	28.37	08.85	00.00	26.56	00.00	08.85	28.78	17.71	08.85	17.71	08.85	18.49
T_9	51.15	42.00	41.15	43.08	44.35	48.85	46.92	46.92	38.85	45.39	08.85	00.00	00.00	13.08	45.39	31.74
Mean	49.71	52.57	55.31	52.82	52.60	44.91	32.30	45.22	35.55	39.50	17.03	21.75	16.28	25.01	39.50	

C.D. at	5%	1%
Month :	4.46	5.86
Treatment x month	13.38	17.59
Treatment :	8.92	10.59
Month x Medium :	8.92	11.72

reported by Mattras (1988), who also found that IBA comparatively more immobile than NAA and hence, it may cause more rooting.

Interaction effect of period of layering and auxin concentration showed that during July treatment T_1 (IBA 25000 ppm) produced significantly higher percentage (82.50%) of rooting over control but which was on par with the treatments T_2 (72.30%).

Month and media interaction also showed that media M_3 gave higher percentage (55.31%) of rooting during July but was at par with other media too for the same month. August and September gave less rooting which may be attributed due to low moisture available in the environment due to reduced rainfall.

Root Characters

Number of Primary Roots

Maximum number of primary roots were observed in treatment T_4-10000 ppm IBA (6.59) which was statistically at par with the treatment T_2 (5.80) but significantly higher over control (Table 2). Among the months of layering, the layers prepared during July recorded significantly higher number of primary roots (6.89) followed by August (4.31). The layers prepared during September month recorded the least number of primary roots par layers (2.30). This showed that the number of primary roots per layers declined from July month onwards. Similar result was also obtained by Ahmad (1964) in guava air layers during rainy season. Significantly higher number of roots during July was attributed presence of high humidity in the environment due to continuous rains.

The synergistic effect between auxin treatments and months gave higher number of primary roots. The shoots treated with 5000 ppm of IBA gave significantly more number of roots (13.00) followed by treatment T_1 (10.87) and T_4 (10.57) over control T_9 (09.22) when the layers made during July. These results agreed with the results of Sadhu *et al.* (1972). This may be due to cumulative effect of IBA and more congenial environmental factors during the month of July.

Table 2. Effect of time, media and growth regulators on number of primary roots of guava (cv. Allahabad Safeda) air-layers

Treat.	July					August					September					Overall Mean
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	
T_1	11.27	10.53	10.87	10.80	1087	05.32	02.58	01.92	04.43	03.56	00.00	00.00	00.00	00.33	00.08	04.84
T_2	10.73	14.60	11.40	15.27	13.00	05.60	03.17	03.33	02.78	03.72	01.00	00.33	00.67	00.67	00.67	05.80
T_3	06.94	07.22	11.80	07.73	0843	07.39	04.50	05.86	05.22	05.74	00.00	01.67	00.00	00.75	00.75	04.97
T_4	10.94	09.19	09.95	12.19	10.57	04.39	07.83	08.28	08.94	07.36	02.67	01.50	02.17	01.83	01.83	06.59
T_5	01.83	04.17	02.67	02.56	02.81	03.30	05.92	01.22	03.50	03.49	03.67	01.86	03.13	04.39	04.39	03.56
T_6	03.00	00.67	02.94	02.50	02.28	05.00	03.83	02.50	05.00	04.08	06.72	07.17	04.67	05.86	05.86	04.07
T_7	03.33	03.11	04.50	04.61	03.89	01.83	05.67	06.11	02.58	04.05	01.67	04.03	07.33	04.15	04.15	04.03
T_8	04.89	07.50	03.33	08.06	05.95	01.00	00.00	01.67	00.00	00.67	06.33	01.00	01.00	02.58	02.58	03.07
T_9	06.08	04.30	03.50	02.96	04.21	05.36	06.78	05.06	07.17	06.09	00.33	00.00	00.00	00.42	00.42	03.57
Mean	06.56	06.81	06.77	07.41	06.89	04.35	04.36	03.99	04.40	04.31	02.49	02.11	02.11	02.30	02.30	

C.D. at	5%	1%
Month :	0.92	1.20
Treatment x month	2.75	3.61
Month x Medium :	1.58	2.08

Table 3. Effect of time, media and growth regulators on length (cm) of primary roots in guava (cv. Allabad Safeda)

Treat.	July					August					September					Overall Mean
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	
T_1	499	4.44	4.60	4.89	4.73	5.43	5.75	2.63	4.81	4.66	0.00	0.00	0.00	1.63	0.41	3.27
T_2	4.98	5.89	3.35	4.94	5.29	4.31	3.68	4.75	3.30	4.01	1.60	0.97	0.20	0.13	0.73	3.34
T_3	5.64	5.56	5.44	5.41	5.51	4.89	4.50	5.77	5.87	5.26	0.00	1.77	0.00	2.57	1.08	3.95
T_4	4.35	5.19	4.01	4.02	4.39	4.53	5.25	4.97	5.05	4.95	2.07	2.80	2.22	4.27	2.84	4.06
T_5	3.37	4.71	4.63	4.61	4.33	4.39	3.26	2.28	3.80	3.43	3.90	3.55	3.50	5.09	4.01	3.92
T_6	3.10	2.30	3.82	3.02	3.06	3.70	3.70	4.44	4.62	4.12	3.43	3.36	1.70	3.56	3.01	3.40
T_7	5.58	3.12	2.68	4.34	3.93	4.47	5.90	4.38	1.57	4.08	2.07	2.82	4.63	2.41	2.98	3.66
T_8	2.04	4.73	3.60	2.84	3.31	1.40	0.00	2.43	0.00	3.96	1.50	0.50	1.77	2.87	1.66	1.98
T_9	3.79	3.81	4.48	3.95	4.01	4.12	3.79	3.26	3.66	3.71	0.90	0.00	0.00	1.08	0.50	2.74
Mean	4.21	4.42	4.29	4.22	4.28	4.14	3.98	3.88	3.63	3.91	1.72	1.75	1.56	2.62	1.91	

C.D. at	5%	1%
Month :	0.49	0.65
Treatment x month	1.48	1.94
Month x Medium :	0.85	1.12

Table 4. Effect of time, media and growth regulators on number of secondary roots of Guava (cv. Allahabad Safeda) air layers

Treat.	July					August					September					Overall Mean
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	
T_1	40.95	37.53	40.67	32.33	37.87	25.80	16.58	06.28	20.63	17.32	00.00	00.00	00.00	0.20	00.50	18.56
T_2	37.18	42.80	42.33	40.53	4076	19.84	22.00	15.00	13.11	17.49	01.33	00.67	00.00	00.00	00.50	19.58
T_3	24.33	25.80	50.35	34.27	33.69	29.67	14.83	28.86	21.36	23.68	00.00	07.33	00.00	08.33	03.92	20.43
T_4	22.91	25.37	23.70	25.05	24.25	23.78	22.61	21.89	21.47	22.44	03.00	03.67	00.67	00.33	01.92	16.20
T_5	07.64	12.33	18.00	14.42	13.10	09.28	18.42	04.67	05.33	09.43	09.33	06.50	10.58	26.72	13.28	11.94
T_6	03.67	05.67	12.89	11.17	08.35	18.33	11.33	06.22	07.00	10.72	17.33	13.50	11.44	10.17	13.11	10.73
T_7	27.58	13.33	15.83	16.44	18.30	03.00	15.33	29.75	04.25	13.08	12.67	11.16	20.11	00.89	11.21	14.20
T_8	12.83	18.00	12.00	14.78	14.40	02.33	00.00	03.00	00.00	01.33	00.33	00.00	01.00	00.00	00.33	05.35
T_9	17.56	10.87	13.83	07.53	12.45	17.94	14.83	13.92	13.83	15.13	00.33	00.00	00.00	00.00	00.08	09.22
Mean	21.72	21.30	25.53	21.83	22.57	16.66	15.10	14.40	11.89	14.51	04.93	04.76	04.87	05.38	04.98	

C.D. at	5%	1%
Month :	0.49	0.65
Treatment x month	1.48	1.94
Month x Medium :	0.85	1.12

Lenth of Primary Roots (cm)

Length of primary roots was found more in treatment T_4- 10,000 ppm IBA (4.06 cm) followed by in treatments T_3 (3.95cm), T_5 (3.92cm) and T_7 (3.66cm). Though, these all the treatments were at par but showed significant results over control (Table 3). In respect to effect of different months, more root ength was noticed in July month (4.28 cm) which is at par with the August air layers (3.91cm) however significantly higher over the month of September (1.91cm).

In July, air layers treated with IBA 7500 ppm (T_3) produced lengthier roots (5.51 cm) but at par with treatment T_2 (5.29 cm) and significant over control (T_9 4.01cm). This might be due to combined effect of auxins and month.

Number of Secondary Roots

Table 4 reveals that treatment T_3 showed higher number of roots (20.43) which was at par with treatment T_2 (19.58) and T_1 (18.56) as compared with control. More number of secondary roots in all these treatments might be due to slow translocation property of IBA or it is destroyed relatively slowly auxin destroying enzyme system.

Significantly more number of roots (22.57) were produced in July followed by August (14.51) and September (4.98) over control, due to high humidity during July and reduced gradually in subsequent months. It was further observed that July month was found to be more effective when compared with other months. Air layers treated with IBA 5000 ppm in July produced significantly higher number of roots (40.76), which was almost equal to treatment T_1 (37.87) when compared with other treatments.

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CONSTRAINTS ENCOUNTERED BY FARMERS IN DIFFERENT PRODUCTION SYSTEMS AND INTEGRATED FARMING SYSTEM IN COASTAL TAMIL NADU

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ABSTRACT

The present study envisaged to asses and analyse the various constraints of individual farm enterprises and integrated farming system as a whole in the coastal Tamil Nadu during 2005. The ranking was done by the farmers based on the importance or severity of the problems in 8 coastal villages. Marketing, input natural calamities in crop production ; low milk price, diseases, decreasing common grazing land in livestock production ; disease and predators in poultry and lack of government support, wide price fluctuations in fisheries were ranked by farmers as major problems in individual enterprises. The major constraints in adopting integrated farming system were found to be heavy investment in the initial stage, lack of marketing for the produces from different enterprises, labour unavailability and its high cost and lack of infrastructure in addition to scattered land holdings of farmers.

Key words : Constraint analysis, integrated farming system (IFS), production system.

Farming systems evolve and change through time with respect to their own logic and the changes which occur in the society. Each individual farm has different physical, biological and human resources which are consciously manipulated by the farmers within the system. Complex agro-ecosystems change rapidly as a result of farmers' decision based on their perception of opportunities and constraints. The constraints analysis helps not only farmers but also researchers to set target objectives, priorities and resource allocation in addition to formulating effective strategies for solving problems. In this connection, a study was undertaken to assess and analyse various constraints relating to production systems and integrated farming system in the coastal Tamil Nadu.

MATERIALS AND METHODS

The study was conducted in two coastal districts of Tamil Nadu namely, Tiruvallur and Thanjavur during 2005 covering 8 villages in 4 coastal blocks. The top two villages which expressed relatively higher extent of IFS in terms of combination of enterprises as well as number of IFS farmers in each block were selected purposively for the study. A complete list of farmers having different enterprise combinations including at least one milch animal was prepared for each of the selected villages. Based on the proportionate random sampling technique, the sample IFS farmers were drawn randomly from the selected villages. The sample IFS farmers were post-stratified based on the combination of enterprises.

In this study, the constraints were operationalised as certain irresistible forces which have been impeding the adoption of particular production system within the farming systems. Before development of the schedule on constraints, an inventory of constraints was prepared by conducting preliminary survey of non-sample villages. It was supplemented with the discussions with few extension officers and researchers and by reviewing the available literature. Based on their views on importance and severity of each constraint, respondents were requested to indicate the constraint as: Most Important (MI), Somewhat Important (SI) and Least Important (LI). After the data collection, the frequencies of MI, SI and LI were found which were again multiplied by 3, 2 and 1, respectively. Their totals were added and later divided by total number of respondents for ranking in order to identify the severity of the constraint in each production system.

RESULTS AND DISCUSSION

There are a number of major constraints affecting the development of farming systems. Many of these constraints are inter-related and exert variable limitations on the operational efficiency and more importantly, the productivity of farming systems. Since the formulation of developmental strategies aimed at reducing and/or overcoming these constraints are dependent on an understanding of the issues and the effects, constraints faced by the respondents related to individual enterprises and integrated farming system as a whole were assessed and discussed in detail and the results have been furnished in Table 1.

Crop production system

Under the crop production system, farmers ranked marketing problems as the number one (2.53) followed by problems relating to input (2.33), natural calamities (2.32), lack of government support (2.27), labour (2.23), pest and disease occurrence (2.00), lack of infrastructure facilities (1.90), financial difficulties (1.87) and non- reclamation of water tanks (1.67). Farmer's unsure of price of their produce, dismal functioning of regulated markets, manipulations of Direct Procurement Centre (DPC) of Tamil Nadu Civil Supply Corporation (TNCSC) such as unauthorised deduction of paddy, delay in setting up of procurement centre, allowing traders to sell the paddy in DPC and corruption of officials involved in procurement, dominance of village merchants exploiting the poor economic conditions of farmers through providing loan and making pre-harvest contract, announcement of uneconomical minimum support price (MSP) by the government etc. were the major marketing issues to be tackled.

Non-availability of critical inputs such as seeds of certain preferred varieties and plant protection chemicals, poor quality of seeds, fertilizers and seedling, escalating cost of inputs such as diesel etc. were the major problems related to input while failure of monsoon, inadequate rainfall flood, cyclone and tsunami were the major natural calamities. Farmers disclosed that poor extension service such as reduced/ nil visit of extension agents to villages, ineffective advisory service, selling of poor quality inputs in agricultural depots, delayed supply of inputs (like seeds, bio-fertilizers) etc., lack of policy support like guaranteed price for farm produce, dealing with laws relating to bonded labour, child labour and protection of wild animals and endangered species etc. have to be given due attention by the governments. The labour availability in peak agricultural seasons, increasing labour costs, labours involving in strike to demand higher wages and meals in certain areas etc. greatly limit the crop production. The damages caused by pest, disease and weeds were felt as major constraints.

Lack of certain infrastructure facilities such as proper road, godown, cold storage, transport, check dams etc. were the major prohibitive factors for increasing the crop production. Non-availability of adequate capital, higher interest charged by local money lenders, formalities demanded by banks, defunct cooperative societies etc. exposed the inability of the farmers to invest in farming to obtain a reasonable rate of return. Farmers also reported that the water tanks, canals and channels were not reclaimed and contractors who did reclamation just took the soil on the sides and dumped it on the bund without actually carrying out the stipulated work.

Livestock production system

Majority of the farmers ranked low price of milk and lack of market as the major problem (2.67), followed by disease occurrence (2.50), reduced availability of grazing land (2.47), labour unavailability (2.37), lack of fodder availability (2.27), unavailability of green fodder in loan season (2.20), lack of veterinary services (2.10) etc. Farmers also reported about high cost of concentrate (1.67), late or no conception of animals (1.47) and non-availability of dairy cooperatives (1.37). These findings were in conformity with the earlier reports of NCA (1976), Gupta and Deepak (1989), Balakrishna

Table 1. Constraints encountered by farmers in different production systems and IFS as a whole

S. No.	Constraints	MI*	SI*	LI*	Weighted score	Rank
Crop production system (n = 150)						
1.	Marketing problems	90	50	10	2.53	I
2.	Input problems	80	40	30	2.33	II
3.	Natural calamities	95	8	47	2.32	III
4.	Lack of government support	85	20	45	2.27	IV
5.	Labour problems	75	35	40	2.23	V
6.	Pest and disease incidence	60	30	60	2.00	VI
7.	Lack of infrastructure facilities	55	25	70	1.90	VII
8.	Financial difficulties	50	30	70	1.87	VIII
9.	Non-reclamation of tanks, lakes and channels	40	20	90	1.67	IX
Livestock production system (n=150)						
1.	Low price for milk	110	30	10	2.67	I
2.	Occurrence of diseases	85	55	10	2.50	II
3.	Decreasing common grazing land	110	20	30	2.47	III
4.	Labour unavailability	75	55	20	2.37	IV
5.	Lack of availability of fodder	65	60	25	2.27	V
6.	Unavailability of green fodder in lean season	70	40	40	2.20	VI
7.	Lack of veterinary services	60	50	40	2.10	VII
8.	High cost of concentrate	25	50	75	1.67	VIII
9.	Lack of sufficient quantity of good quality water	30	30	90	1.60	IX
10.	Late or no conception of animals	25	20	105	1.47	X
11.	Non-availability of dairy cooperatives	20	15	115	1.37	XI
Backyard poultry production system (n=115)						
1.	Disease incidence	75	20	20	2.47	I
2.	Damaging agricultural crops and cattle feed	30	60	25	2.04	II
3.	Problem of predators	45	20	50	1.95	III
4.	Low genetic potential	30	30	55	1.78	IV
5.	Polluting house environment	25	30	60	1.69	V
Fisheries production system (n=12)						
1.	Lack of government incentives	9	2	1	2.67	I
2.	Wide fluctuations of market price	8	2	2	2.50	II
3.	Inadequate infrastructure facilities	7	3	2	2.42	III
4.	Inadequate availability of inputs in quality and time	6	4	2	2.33	IV
5.	Disease incidence	4	2	6	1.83	V
6.	Predators problem and theft of the produce	2	3	7	1.58	VI
Integrated farming system as a whole (n=150)						
1.	Heavy investment in the initial stage	90	40	20	2.47	I
2.	Lack of marketing for the produces from different enterprises	50	70	30	2.13	II

3.	Labour unavailability and its high cost	50	60	40	2.07	III
4.	Lack of infrastructure and scattered land holding	55	45	50	2.03	IV
5.	Lack of know-how on effective utilisation of farm produce	30	80	40	1.93	V
6.	Non-availability of improved cultivars/breeds at farm site	40	40	70	1.80	VI
7.	Reduced grazing land	30	50	70	1.73	VII
8.	Lack of input availability	50	20	80	1.68	VIII

*MI-Most Important ; SI-Somewhat Important and LI-Least Important

(1997) and Mary (2001) who observed similar constraints related to infrastructure, marketing and supply and services in their study. Pandey *et al.* (2002) expressed that feed was the major cost that made milk production uneconomical.

Farmers in the coastal regions generally receive the price varying from Rs. 7 to 9 per kg of cow milk and Rs. 8 to 10 per kg of buffalo milk as there is no facility for value addition of milk (processing plants) and non-existence or shabby functioning of dairy cooperatives. Despite four of the study villages being nearer to Chennai city, farmers could not run dairy enterprise on profit basis as there is already well established supply structure (Aavin) to cater to the needs of metropolitan city by procuring milk from villupuram and western districts of Tamil Nadu. The diversion of common grazing lands to establish shrimp farms and other public activities apart from encroachment by influentials in the coastal areas has significantly contributed to 'decline in livestock holding of individual farmers in addition to non-availability of labour for grazing the cattle. Purchasing fodder and feed from market made the dairy farming unviable as revealed by the farmers. Inappropriate location of veterinary hospitals is another lacuna which is to be handled by encouraging more private veterinary practice.

Poultry production system

Free range rearing of backyard poultry was being done with minimum supplementation of locally available ingredients. The disease incidehce (2.47), damaging nearby agricultural crops, seedlings and feed and fodder on cattle shed (2.04), predator's problem (1.95), low genetic potential (1.78) and polluting house environment (1.69) were ranked first to fifth important constraints by poultry holders. These problems are common as the birds are allowed to scavenge outside in the field from morning to evening. Conroy *et al.* (2005) revealed that high mortality due to predators such as wild cat, fox, kites, crows, snake and mongoose and diseases such as Newcastle disease, fowl fox and fowl cholera along with gastro-intestinal parasites and poor hatchability were the major constraints of backyard poultry in a study conducted in Trichy district of Tamil Nadu.

Fisheries production system

Farmers from aquaculture production system disclosed their prioritized constraints as: lack of government support (2.67), wide fluctuation of market price (2.50), inadequate infrastructure facilities (2.42), inadequate availability of inputs both in time and quality (2.33), disease outbreak (1.83) and predator's (such as frog, snake, birds) and theft of the produce (1.58). Similar results were revealed by Ponnusamy *et al.* (2001). The government's lack of support in providing concessional electricity tariff, establishment of cold chains, arrangement of refrigerated vans, concessional bank loan, establishment of fish hatcheries (particularly for grass carp) etc. in fact de-motivates the farmers who are already in the production system and others who intend to enter this venture. Due to the perishable nature of fish commodity, farmers could not store it for long and has to be disposed in the widely fluctuating both shrimp and fish markets. The quality inspection of various inputs such as seeds, feeds, antibiotics etc. supplied by many private unauthorised companies need to be ensured along with timely availability of these inputs. The research support for practising the integrated farming system with fisheries component to the various agro-climatic regions is also lacking. The extension service of the department of fisheries is mostly confined to issuance of license and preparation of written records leaving the knowledge and skill delivery to the corner.

Integrated farming system as a whole

The constraints as perceived and ranked by the farmers in order of priority in adoption of integrated farming system were: heavy investment in the initial stage (2.47), lack of marketing for the produces from different enterprises (2.13), labour unavailability (2.07), lack of infrastructure and scattered land holding (2.03), lack of know-how on effective utilisation of farm produce (1.93), non-availability of improved cultivars! breeds at farm site (1.80), reduced grazing land (1.73) and lack of input availability (1.68). Jayanthi *et al.* (2002) observed similar findings.

Starting of integrated farming system involving several enterprises is likely to incur heavy expenditure due to appropriate selection and purchase of site, inputs, accessories etc. Moreover, farmer need to analyse market situation, potential and constraints for all the produces that he is producing as lack of market will make the system unviable in the long run. The village youngsters preferring white collar jobs are unwilling to involve themselves in the farming. It is observed that a youth or middle-aged person wishes to earn only Rs. 40 to 50 per day in a city or town but unwilling to work in the field as a labourer for an amount of Rs. 80 to 100 per day with a provision of meal. The tendency of individuals towards respecting farming as a heavenly profession is declining even in rural areas. The scattered land holdings coupled with subdivision and fragmentation leads to poor investment, improper choice of crops and enterprises adoption and meagre profitability. Non availability of certain critical inputs and lack of certain infrastructure facilities such as good road, storage etc. also inhibit the farmer in adopting the IFS.

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INTEGRATED NUTRIENT MANAGEMENT IN WHEAT (*TRITICUM AESTIVUM*)

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ABSTRACT

Field experiment was conducted at Research Farm of R.B.S. College, Bichpuri, Agra during *rabi* season of 2000-01 and 2001-02, with eleven treatments viz., control, *Azotobacter, Azospirillum*, FYM @ 5 t/ha, 50 kg N/ha, 100 kg N/ha, 150 kg N/ha, 50 kg N/ha + *Azotobacter*, 50 kg N/ha + *Azospirillum*, 50 kg N/ha + *Azotobacter* + FYM @ 5 t/ha and 50 kg N/ha + *Azospirillum* + FYM @ 5 t/ha. Results revealed that the application of 150 kg N/ha may be replaced by the various combination of biofertilizers, FYM and chemical fertilizes which will be more remunerative in terms of low input cost and sustainable productivity and soil health for longer period.

Key words : Biofertilizers, inorganic fertilizers, farm yard manure.

No doubt chemical fertilizer will continue to be the main components for meeting the increased crop nutrient needs of the country. However, due to energy crisis, their use has become the costliest input, which constitutes about 30-40 per cent of farmer's budget for wheat production. Moreover, the fertilizer production in the country is not meeting the actual requirement and the deficit has to be made through import, which involves a lot of foreign exchange. In addition to sky rocketing prices of nitrogenous fertilizers, their contribution towards land degradation and environmental pollution are the maior threats in near future. However, at the some time large-scale use of nitrogenous fertilizers has created many complex production problems in the form of deficiencies and toxicity of various nutrient element in the soil. Thus, it is high time to reduce the level of inorganic fertilizer use in crop production by substituting with its various organic sources and biofertilizers.

The recent concept of integrated use of various sources (organic, inorganic and biofertilizer) of nutrient in crop production has started gaining ground. The basic concept underlying the principal of integrated nutrient supply system is the improved of soil fertility for sustainable crop production on long-germ basis. It may be achieved through integrated use of all the possible sources of plant nutrients and their scientific management in different crops and cropping systems.

It is evident that biofertilizers like *Azotobacter* and *Azospirillum* alone or in combination have great prospect for increasing the productivity of wheat (Battersperger *et al.* 1978). However, very little information is available regarding the effect of *Azotobacter* and *Azospirillum* combination with farm yard manure and inorganic nitrogen fertilizers under field conditions.

MATERIALS AND METHODS

Field experiments were conducted at the Research Farm of R.B.S. College, Bichpuri, Agra, during the *rabi* season of 2000-01 and 2001-02, under irrigated condition. The experiment was laid out in randomized block design with four replications. The soil of the experimental field was sandy loam texture, low in available nitrogen, medium in phosphorous and high in potash.

Eleven treatment combinations consist of biofertilizers, nitrogen levels and farm yard manure viz., control, *Azotobacter*, *Azospirillum*, FYM @ 5t/ha, 50 kg N/ha, 100 kg N/ha, 150 kg N/ha, 50 kg N/ha + *Azotobacter*, 50 kg N/ha +

Azospirillum, 50 kg N/ha+*Azotobacter* + FYM @ 5t/ha and 50 kg N/ha + *Azospirillum* + FYM @ 5 t/ha). Wheat variety PBW 343 was sown on 23 November in 2000 and 25th November and in 2001. Nitrogen applied through urea. Half of N dose was applied at time of sowing and remaining half after the first irrigation. A uniform dose of 70 kg P_20_5 and 50 kg K_2O/ha through single super phosphate and muriate of potash were incorporated into the soil before sowing.

RESULTS AND DISCUSSION

Effect of biofertilizers

Application of biofertilizers (*Azospirillum* and *Azotobacter*) significantly increased number of tillers/m^2, ear length, number of grains/ear, test weight and yield of wheat grain and straw compared to control during both the years. Increase in yield attributes and yield of wheat with biofertilizer might be due to increased supply of plant forms. The higher values of yield attributing characters and yield of wheat due to biofertilizer has been reported by Tomar *et al.* (1995). Seed inoculation with biofertilizers enhanced nitrogen uptake and protein yield of wheat grain and straw as compared to uninoculated control. This is due to the fact that plants usually assimilate nitrogen ions indefinite deficient proposition increase the availability of the nutrient and usually result in better uptake and utilization of nutrients. Similar beneficial effect in wheat reported of Bhattarai and Hess (1993).

Effect of farm yard manure

Farm yard manure treated plots significantly increased number of tillers/m^2, ear length, number of grains/ear, test weight and yield of wheat crop over to control in both the years. Nitrogen uptake and protein yield was remarkably in wheat grain and straw due to FYM treated plots (Table 2). The increase in yield attributing character yield of grain and straw and nitrogen uptake and protein yield due to FYM application due to indirect effect on the enhanced availability of both soil and fertilizer nutrients besides microbial activity and improved root development. Increase in yield attributes and yield of wheat with application of FYM has also been observed by Tomer *et al.* (1995).

Effect of nitrogen fertilizer

Nitrogen is an important and major nutrient for all the crops. The increasing level of nitrogen up to 150 kg N/ha increased number of tillers/m^2, ear length, grains per ear, 1000 grain weight and yield of grain and straw during both the years. Among all the macronutrients, nitrogen contributes maximum developments of plants, yield attributes and yield of wheat. Nitrogen application increase the accumulation of photosynthesis in ear heads, thereby increase the ear length in wheat. These results are in agreement with the finding of Singh and Uttam (1993) and Mishra *et al.* (1994). Higher amount of N removed by wheat with the addition of fertilizer N was due to increase in yield and also N uptake in grain and straw of wheat with the increase in fertilizer N was also reported by Prasad *et al.* (2000).

Combined effect of nitrogen and biofertilizers

Bio-fertilizer along with nitrogen fertilizer as a desirable practice sustaining higher crop productivity. Incorporation of bio-fertilizers and chemical fertilizers by way of affecting savings in doses of chemical fertilizers, takes off some of the financial burden of the farmers.

Combined application of *Azospirillum* or *Azotobacter* with 50 kg N/ha significantly increased total tillers/m^2, ear length, number of grains/ear, test weight, grain and straw yield of wheat over uninocuted control. Increased in yield attributes and wheat yield with bio-fertilizer and nitrogen might be due to increased supply of plant hormones by the microorganism and nitrogen also play an important role in improving the yield attributes, thus results in higher yield. Similar findings were reported by Prasad *et al.* (2000).

The higher values of yield attributing characters and finally yield of wheat due to *Azospirillum* inoculation with 50 kg N/ha have been found superior over *Azotobacter* with same combination. Seed inoculation with *Azospirillum* and 50 kg N/ha application enhanced nitrogen uptake and protein yield of grain and straw as

Table 1. Number of tillers/m², length of ear, number of grains/ear, test weight, grain, straw yield of wheat as affected by biofertilizers, FYM and nitrogen

Treatments	Tillers/m²		Length of ear (cm)		No. of grains/ear		Test weight (g)		Grain yield (q/ha)		Straw yield (q/ha)	
	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02
Control	191.7	195.9	7.1	7.7	31.1	32.4	33.2	33.1	26.5	27.7	45.9	46.1
Azotobacter	262.2	268.2	9.6	9.8	36.1	36.2	36.7	37.6	34.6	35.3	55.8	57.1
Azospirillum	264.6	270.9	9.7	10.0	36.6	36.7	36.6	37.5	35.9	36.0	56.4	58.1
FYM@5t/ha	266.2	273.0	9.4	10.0	37.8	37.8	37.4	37.3	35.3	37.9	56.8	58.2
50 kg N/ha	270.9	274.5	9.8	10.5	36.9	37.1	38.5	38.5	37.5	38.2	58.9	59.5
100 kg N/ha	307.2	308.1	10.8	11.3	39.4	40.5	41.5	42.4	46.7	47.4	65.2	67.1
150 kg N/ha	324.9	325.2	11.7	12.1	40.7	41.9	42.5	43.4	48.8	49.5	67.3	67.9
50 kg N/ha + *Azotobacter*	301.2	297.9	10.7	10.6	39.5	40.9	41.8	42.2	44.0	45.8	64.3	65.5
50 kg N/ha + *Azospirillum*	305.1	302.7	10.8	11.0	39.6	41.1	41.8	42.8	44.4	45.2	64.4	65.9
50 kg N/ha + *Azotobacter* + FYM@5t/ha	329.4	335.1	11.5	11.8	41.3	41.3	42.8	43.7	48.0	48.6	66.8	67.6
50 kg N/ha + *Azospirillum* + FYM @ 5t/ha	330.6	338.4	12.2	12.2	41.4	41.3	42.7	43.1	48.2	48.8	68.0	67.9
SEm±	6.4	6.4	0.2	0.2	0.9	0.9	0.7	0.7	0.9	1.0	1.4	1.7
CD at 5%	18.9	19.0	0.7	0.7	2.3	2.3	2.0	2.2	2.8	3.1	4.1	5.0

Table 2. Nitrogen uptake in grain and straw, protein yield in grain and straw of wheat as affected by biofertilizers, FYM and nitrogen

Treatments	Nitrogen uptake (kg/ha)				Protein yield (kg/ha)			
	Grain		Straw		Grain		Straw	
	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02
Control	40.6	42.6	19.9	17.5	253.6	226.5	111.5	109.8
Azotobacter	54.7	56.4	24.0	25.1	242.1	352.7	150.1	157.0
Azospirillum	57.4	61.3	29.3	27.0	358.50	364.7	151.8	163.3
FYM@5t/ha	57.1	58.5	25.6	26.8	357.3	383.9	159.5	167.7
50 kg N/ha	67.9	68.3	27.1	28.0	424.5	427.1	169.6	174.8
100 kg N/ha	88.8	91.0	31.9	33.6	555.3	568.6	199.3	210.1
150 kg N/ha	95.2	96.9	33.7	35.3	595.1	605.9	210.8	220.5
50 kg N/ha + *Azotobacter*	81.0	83.4	28.9	30.8	506.0	521.2	180.6	192.5
50 kg N/ha + *Azospirillum*	82.1	83.2	29.6	31.7	512.9	519.9	184.8	197.8
50 kg N/ha + *Azotobacter* + FYM@5t/ha	92.6	94.7	32.8	33.8	578.9	590.0	204.6	211.5
50 kg N/ha + *Azospirillum* + FYM @ 5t/ha	93.9	95.2	33.5	35.2	587.2	594.9	209.7	220.2
SEm±	1.9	1.9	0.6	0.7	11.5	12.6	4.3	4.6
CD at 5%	5.7	5.7	1.8	2.1	33.8	37.0	12.7	13.5

compared to uninoculated control. This due to the fact that plant usually assimilate nitrogen ions in definite deficient population increase the availability of nutrient, usually result in better uptake and utilization of other nutrient. Similar beneficial effect in wheat reported by Singh and Uttam (1993).

Combined effect of nitrogen, biofertilizer and FYM

Interaction between inorganic, biofertilizer and FYM was significant during both the years for all characters. Yield of grain and straw obtained with the application of above combination was similar to the yield obtained at 150 N/ha. Treatment combination 50 kg N/ha + *Azospirillum* + FYM @ 5 t/ha was better than 50 kg N/ha + *Azotobacter* + 5 t/ha and other treatments. Among the biofertilizers, *Azospirillum* proved superior over *Azotobacter*, as *Azospirillum*, a good microacrophilic N fixer. Biofertilizer could be used to replace some of the N fertilizer requirement also reported by Singh and Uttam (1993). Combined effect of biofertilizers, nitrogen and FYM as N uptake by grain and straw were significant over control during both the years of experimentation. Maximum N uptake in grain (93.93 and 95.18) and straw (33.50 and 35.24) was confirmed with the application of *Azospirillum* +50 kg N/ha + FYM (5 t/ha). Interaction between 50 kg N/ha, *Azotobacter/Azospirillum* and FYM @ 5t/ha were observed to be significantly in two years. Among the combinations, 50 kg N/ha + *Azospirillium* + FYM @ 5 t/ha was the best which gave highest values of protein yield (587.19, 594.94 in grain and 209.71, 220.22 in straw). This observation in conformity with the findings of Prasad *et al.* (2000) and Mohiuddin *et al.* (2000).

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EFFECT OF NITROGEN AND PHOSPHORUS ON VEGETATIVE GROWTH AND FLOWER YIELD OF CHRYSANTHEMUM (*CHRYSANTHEMUM MORIFOLIUM*) CV. NILIMA

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ABSTRACT

The effect of four levels of N (0, 150, 300 and 450 kg ha^{-1}) and P (0,150, 300 and 450 kg ha^{-1}) on growth, flowering and yield of chrysanthemum cv. 'Nilima' was investigated in factorial randomized block design with three replications at Horticulture Farm, Rajasthan College of Agriculture, MPUAT, Udaipur. Results reveated that application of nitrogen and phosphorus @ 300 and 150 kg ha^{-1}, respectively in chrysanthemum cv, Nilima proved to be the optimum doses for obtaining higher flower yield ha^{-1}.

Key words : Chrysanthemum, nitrogen, phosphorus, plant spread, flowering duration, flower yield.

The chrysanthemum is popularly grown throughout the world for commercial flower production. It occupies second position in flower production in the world after rose and in India, it ranks third after jasmine and rose. It is mainly used for decoration either in gardens or pots, supplied as loose flower for garlands and for cut flowers, hair decorations for the ladies (veni), for worship and large bloom used for exhibitions.

Chrysanthemum is heavy feeder and has large requirement of nutrients. It has been established that the nutrition plays an important role in the improvement of vegetative growth and flower yield in chrysanthemum (Chezhiyan *et al.* 1986).

At present, due to lack of scientific knowledge, growers are not able to boost the productivity of chrysanthemum. In view of this fact and over-riding need was felt to conduct research to find out the fertilizer requirements of nitrogenous and phosphatic fertilizers. Hence, this study was conducted to analyze the effect of N and P_2O_5 to optimize the nutritional requirements of chrysanthemum cv. Nilima.

MATERIALS AND METHODS

The experiment was conducted at the Horticulture Farm, Rajasthan College of Agriculture, MPUAT, Udaipur (Raj.) during 2001-2002. The treatments consisted of combinations of four levels of N and P_2O_5 *viz.*, 0 (N_0), 150 kg ha^{-1} (N_1), 300 kg ha^{-1} (N_2) and 450 kg ha^{-1} (N_3) and 0 (P_0), 150 kg ha^{-1} (P_1), 300 kg ha^{-1} (P_2), 450 kg ha^{-1} (P_3). The effect of eight treatments were studied in factorial randomized block design with three replications.

The FYM @ 35 t ha^{-1}, full dose of P_2O_5 and half dose of N were applied before transplanting and the remaining half dose of N was top dressed after one month of transplanting. The nutrients were applied in the form of urea and single super phosphate. Biometric characteristics like plant height at the time of first bud appearance, spread of plants, days taken to first flower bud appearance after transplanting, duration of flowering, number of flowers per plant and yield of flowers ha^{-1} were recorded on five tagged plants of each plot.

RESULTS AND DISCUSSION

Effect of nitrogen

Different levels of nitrogen significantly increased all the vegetative growth and flower yield parameters as compared to control (Table 1). However, difference between various N levels were found to be non-significant.

Table 1. Effect of nitrogen on vegetative growth and flower yield of chrysanthemum cv. 'Nilima'

Treatments	Plant height at first bud appearance (cm)	Plant spread (cm)	Days taken to first flower bud appearance after transplanting	Duration of flowering (days)	No. of flower per plant	Yield of flower (t/ha)
N levels (kg/ha)						
N_0	40.48	18.59	61.67	28.75	20.19	5.34
N_1	41.92	21.26	55.92	35.17	31.57	7.72
N_2	43.02	24.83	53.17	39.92	40.64	10.61
N_3	42.00	24.26	58.75	38.67	36.85	9.62
C.D. at 5%	1.564*	1.515*	2.160*	1.621*	1.032*	0.618*

Application of N_2 treatment (300 kg N ha^{-1}) resulted in maximum plant height (43.02 cm) at the time of first flower bud appearance and maximum plant spread (24.83 cm) whereas, minimum height of plant (40.48 cm) and minimum plant spread (18.59 cm) were recorded in control.

The present findings are in close conformity with Mishra (1998) in gaillardia. Baboo and Sharma (1997) also found the best results on vegetative growth parameters in chrysanthemum with the application of N and K @ 300 and 160 kg ha^{-1}, respectively.

The increase in various vegetative growth parameters of chrysanthemum as a result of nitrogen application may be attributed to the association of nitrogen in the synthesis of protoplasm and primarily in the manufacture of amino acids and increase in auxin activities brought about the nitrogen fertilizer as a result of increased meristematic activities and hence the vegetative growth of plant increased (Tisdale and Nelson, 1975).

It is evident from the data (Table 1) that all the levels of nitrogen had significant effect on various flowering and yield characters over control. Among the various treatments of nitrogen, the earliest first flower bud appearance (53.17 DAT) and maximum duration of flowering (39.92 days) were recorded at N_2 treatment. The maximum days (61.67) required for first flower bud appearance after transplanting and minimum duration of flowering (28.75 days) were observed in control.

The present findings for appearance of first flower bud and duration of flowering are in accordance with the findings of Bhattacharjee *et al.* (1982) who observed that the application of 20 g N m^{-2} induced early flower bud appearance in hippeastrum. Kumar and Singh (1998) also observed the maximum periodicity of flowering (18.55 days) with the application of 300 kg N ha^{-1} as compared to control (13.80 days) in tuberose. The decrease in days taken to first flower bud appearance may be explained by the fact that higher content of nitrogen might have also accelerated protein synthesis which promote earlier floral primordia development (Vijaykumar and Shanmungavelu, 1978). Increase in duration of flowering due to application of nitrogen, results in greater assimilation of carbohydrates in plant, which would have increased duration of flowering (Saini *et al.*) 1978.

Likewise, the number of flowers per plant and yield of flower (tonnes ha^{-1}) were significantly increased due to application of different nitrogen treatments over control. The maximum number of flowers (40.64 per plant) and highest yield (10.61 t ha^{-1}) were recorded in N_2 treatment. Whereas, the minimum number of flower (20.19 per plant) and lowest yield (5.34 t ha^{-1}) were recorded in control (Table 1).

These findings are in accordance with the results obtained by Rao *et al.* (1992) in chrysanthemum, Baboo and Sharma (1977) also reported the similar increase in number of flowers per plant with increased rates of nitrogen in annual chrysanthemum. The increase in number of flowers and yield with application of nitrogen, might be due to the fact that applied nitrogen had significantly increased the growth

Table 2. Effect of phosphorus on vegetative growth and flower yield of chrysanthemum cv. 'Nilima'

Treatments	Plant height at first bud appearance (cm)	Plant spread (cm)	Days taken to first flower bud appearance after transplanting	Duration of flowering (days)	No. of flower per plant	Yield of flower (t/ha)
P levels (kg/ha)						
P0	39.68	20.82	59.50	34.58	28.20	7.15
P1	44.14	23.07	55.33	36.75	38.65	9.50
P2	42.44	22.57	56.92	36.00	33.54	8.59
P3	41.16	22.48	57.75	35.17	28.86	8.05
C.D. at 5%	1.564*	1.515*	2.160*	N.S.	1.032*	0.618*

*= Significant at 5% level ; NS = Non-significant

parameters, which might have synthesized more plant metabolities which ultimately lead to increased flower production (Chan, 1959).

Effect of phosphorus

Application of phosphorus at P_1 level (150 kg ha^{-1}) significantly influenced various vegetative growth, flowering and yield parameters (Table 2). However, duration of flowering was non-significantly affected by different treatments of phosphorus.

The application of P_1 treatment resulted in maximum plant height (44.14 cm) and maximum plant spread (23.07 cm) whereas, minimum plant height (39.68 cm) and minimum spread of plant (20.82 cm) were recorded in control. The similar increase in plant height due to application of phosphorus was recorded by Jana and Paul (1991) in cosmos.

The possible explanation for increase in various vegetative growth parameters of chrysanthemum due to application phosphorus, may be attributed to some of the established fact that the phosphorus is one of the major element and being a constituent of nucleoprotein, known to play a leading role in photosynthesis, cell division and tissue formation (Arnon, 1959). Phosphorus is also an integral part of sugar phosphate (ATP and ADP) which is necessary for photosynthetic and respiratory processes.

The increase in vegetative growth by phosphorus has been reported by Chezhiyan *et al.* (1986) in chrysanthemum and Singh and Sangama (2000) in China aster.

Among all the levels of phosphorus, P1 level required significantly minimum days taken to first flower bud appearance (55.33 DAT) as compared to maximum in control (59.50 DAT). The duration of flowering was non-significantly influenced by the different treatments of phosphorus in the present investigation (Table 2). Similar non-significant effect of phosphorus on duration of flowering in China rose was reported by Shardool (2000) which lends support to the present findings.

The maximum number of flowers (38.65 per plant) and maximum yield (9.50 t ha^{-1}) were recorded at P1 treatment as compared to the minimum number of flowers (28.20 per plant) and yield (7.15 t ha^{-1}) in control.

The findings of present investigation are supported by Chezhiyan *et al.* (1986) in chrysanthemum and Jana and Paul (1991) in cosmos cv. Super sunset. The increase in number of flowers and yield with the use of phosphorus may be due to improvement in various vegetative growth parameters of chrysanthemum. A vigrous plant with increased number of green leaves containing high amount of chlorophyll is likely to increase the assimilation of carbohydrate. This will improve the source sink relationship with greater portioning coefficient which might increase the number of flowers per plant. Carbohydrate is also a constituent part of nucleoprotein and sugar phosphate (ATP and ADP). Thus, it appears that increased plant metabolites might have produced more yield of flowers.

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INTEGRATED PLANT NUTRIENT SUPPLY SYSTEM IN PREDOMINANT SUB-TEMPERATE MIDHILL CROPPING SYSTEMS OF JAMMU THROUGH PARTICIPATORY APPROACH

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ABSTRACT

A field experiment with two predominant cropping system, *viz.*, rice (*Oryza sativa*)-wheat (*Triticum aestivum* L.) and maize (*Zea mays*)-wheat were carried out for three years (2001-02 to 2003-04) in participatory mode on farmer's fields in Jammu. Treatments compr *in-situ* green manuring *Dhaincha* + 100 and 50% recommended NPK in rice -wheat cropping system whereas in maize-wheat cropping system instead of green manuring, farmer's practice was taken as a treatment for comparison. The treatments Dhaincha (GM) + 100% NPK, No FYM + 100% NPK, FYM @ 5t/ha + 100% NPK, FYM @ 5t/ha + 50% NPK in rice-wheat cropping system gave 19.5, 14.5, 25.4 and 4.8% higher net returns over GM+50% NPK. In maize-wheat system, the treatments FYM @ 5 t/ha + 100% NPK, FYM @ 5 t/ha + 50% recommended NPK and no FYM + 100% NPK gave 31.5, 9.5 and 19.0% higher net returns over farmer's practice, respetively. Use of FYM in combination with chemical fertilizers in rice-wheat and maize-wheat resulted in 50% saving of chemical fertilizers, as the produtivity was omparable with 100% chemical fertilizers alone. *In-situ* green manuring in rice compared well with FYM with respect to crop yields at same level of chemical fertilizers and recorded highest benefit-cost ratio. Integratd plant nutrient supply (IPNS) system in rice-wheat and maize-wheat cropping system improved soil fertility after 3 crop cycles.

Key words : Rice-wheat, maize-wheat, IPNS, yield, soil fertility.

Rice and maize based cropping in rainy season followed by wheat in winter are the two major cropping systems in foot hills of Shivalik ranges of Jammu. These cropping systems need generous application of fertilizers to meet the needs of crops. Integrated plant nutrient supply system (IPNS) involving conjunctive use of chemical fertilizers and organic sources has great significance for improvng crop productivity due to inadequate availability of fertilizers. IPNS leads to soil and crop sustainability by balanced application of materials as these supply micronutrients to meet the crop needs which is also pre-requisite to increase fertilizer use-efficiency (Singh *et al.*, 1999). Keeping above facts in view, the present study was undertaken to find out the effect of IPNS on crop productivity and soil fertility in rice-wheat and maize-wheat cropping system in sub-temperate hill ecosystem of Jammu.

MATERIALS AND METHODS

A field experiment was conducted in a participatory mode on cultivator's field on two cropping systems, *viz.*, rice-wheat and maize-wheat for three consecutive years from 2001-02 to 2003-04. The treatments applied to rainy season crops were T_1 : No FYM +recommended NPK, T_2 : FYM @ 5t/ha+recommended NPK, T_3 : FYM @ 5t/ha+50% recommended NPK, T_4 : *In-situ* Dhaincha (GM) + 100% recommended NPK, T_5 : *In-situ* Dhaincha (GM) + 50% recommended NPK-in rice; whereas in maize, T_4 and T_5 were replaced by the treatment where normal farmer's practice (T_4) was taken for comparison.

The recommended dose (100%) of fertilizers for rice, maize and wheat were 100:50:25, 60:40:20 and 60:30:20 kg/ha of N, P_2O_5 and K_2O, respectively. In farmer's practice, the fertilizers dose was 60:0:0 kg N, P_2O_5 and K_2O ha^{-1} for all the crops.

The plot size was 500 m^2 and the experiment at individual farmer's field constituted 1-replication of randomized block design laid out at 5-locations in Udhampur and Rajouri districts for each cropping system. The transplanting of rice and sowing of maize and wheat were done at optimum time. The experiment was laid out at the same site each year. Net returns and benefit cost ratio for each treatment was worked out on the basis of market value of inputs and products. Soil fertility changes with respect to pH, organic carbon, available NPK were worked out and presented in Table 3 and 4.

In rice-wheat cropping system, the soil texture varied from clay loam to loam, having pH 6.5-6.8, organic carbon 0.43-0.46%, available N, P and K were 190.4-201.2, 17.5-20.6, 175.3-182.4 kg/ha, respectively. Whereas in maize-wheat system, the soil was sandy clay loam to clay loam having pH 6.5-6.8, organic carbon 0.38-0.41%, available N, P and K, 182-192, 15.2-16.1, 132-142 kg/ha, respectively.

RESULTS AND DISCUSSION

Rice- wheat system

Crop productivity under this system had little seasonal variation (Table 1). Mean data of three years indicated that maximum grain yield of rice (4,246 kg/ha) was recorded in treatment where FYM @ 5t/ha +100% NPK was applied closely followed by *in-situ* Dhaincha (GM)+100% NPK which, however, recorded significantly higher grain yield of rice as compared to all other treatments during each year. In case of wheat, applications of 100% NPK in combination with FYM @5t/ha and *in-situ* incorporation of Dhaincha (GM) reorded statistically similar grain yield vales along with the treatment where FYM @ 5t/ha + 100% NPK was imposed and gave maximum grain yield. However, significantly lower grain yield was recorded where 50% NPK was applied either in combination with FYM@ 5t/ha or where *in-situ* Dhaincha crop was grown for green manuring. The treatment *in-situ* Dhaincha (GM) + 50% NPK produced lower grain yield than all other treatments. The net returns were 14.5, 25.4, 4.8 and and 19.5 per cent higher with 100% NPK, FYM 5t/ha + 100% NPK, FYM 5t/ha +50% NPK and *in-situ* Dhaincha (GM) + 100% NPK over the treatment *in-situ* Dhaincha (GM) + 50% NPK. Hedge and Pandey (1989) reported beneficial effect of cropping system where organic sources were used. Suman Mehta (2004) and Singh *et al.* (1999) have also reported similar findings for wheat based cropping system. Integrated plant nutrient supply treatments conspicuously improved the soil fertility parameters like organic carbon, available N, P and K (Table 3). Applications of 100% NPK resulted in greater build up of nutrients in soil as compared to 50% NPK addition where the soil nutrient availability in some cases declined below the initial value in rice-wheat cropping system.

Maize-wheat system

The yearly variations in yield performance of crop were only seasonal and were not large in rainy as well as in winter seasons (Table 2) and in general, the yield increased slightly with each successive year. Mean yield of three years showed that significantly highest grain yield of maize (3, 623 kg/ha) and wheat (2897 kg/ha) were obtained when 100% NPK was applied along with 5t/ha FYM followed by the treatments FYM @ 5t/ha +50% NPK and No FYM + 100% NPK. The farmer's practice produced significantly lower grain yield of both maize and wheat crops as compared to all other treatments. The net returns were 19.0, 31.5 and 9.5% more in No FYM+100% NPK, FYM@ 5t/ha+100% NPK and FYM @ 5t/ha +50% NPK over farmer's practice. There was a positive trend in yield of both the crops with incorporation of FYM along with chemical fertilizers. The effect may be due to more solubilization of added organic P through FYM by soil micro flora. Thus more yield could be obtained with continued incorporation of FYM in conjunction with chemical fertilizers, which maintained the soil fertility status (Table 4) and resulted in the sustainability of the system. Similar were the findings of Singh *et al.* (2004) and Hedge and Diwedi, 1992.

Applications of FYM or *in-situ* green manuring in conjunction with chemical fertilizers in rice-wheat and maize-wheat cropping systems gave more yields and net returns than the 100% recommended NPK fertilizers. Rice-wheat

Table 1. Effect of IPNS on yield and net returns under rice-wheat cropping system (Udhampur)

Year	Particulars	Treatment					
		T_1	T_2	T_3	T_4	T_5	C.D. (P=0.05)
2001-02	Rice yield (kg/ha)	3802	4148	3724	4043	3621	90.35
	Wheat yield (kg/ha)	3075	3279	2950	3105	2820	232.9
	Gross returns (Rs/ha)	42800	46202	41519	44441	40056	
	Cost of cultivation (Rs/ha)	23011	22213	23066	23390	23288	
	Net returns (Rs/ha)	19789	23989	18453	21051	16768	
	Benfit : Cost ratio	1.86	2.08	1.80	1.90	1.72	
2002-03	Rice yield (kg/ha)	3898	4252	3812	4128	3762	129.5
	Wheat yield (kg/ha)	3190	3378	3005	3220	2939	235.9
	Gross returns (Rs./ha)	44123	47469	42405	45698	41676	
	Cost of cultivation (Rs/ha)	23470	25249	24654	24437	23815	
	Net returns (Rs/ha)	20653	22220	17751	21261	17861	
	Benefit : Cost ratio	1.88	1.88	1.72	1.87	1.75	
2003-04	Rice yield (kg/ha)	3984	4338	3946	4239	3830	128.8
	Wheat yield (kg/ha)	3210	3395	3020	3246	2958	237.4
	Gross returns (Rs/ha)	44769	48096	43306	46533	42207	
	Cost of cultivation (Rs/ha)	23941	27173	23409	24884	23319	
	Net returns (Rs/ha)	20828	20923	19897	21649	18888	
	Benefit : Cost ratio	1.87	1.77	1.85	1.87	1.81	
Mean	Rice yield (kg/ha)	3895	4246	3827	4137	3738	
	Wheat yield (kg/ha)	3158	3351	2992	3190	2906	
	Gross returns (Rs/ha)	43897	47256	42410	45557	41313	
	Cost of cultivation (Rs/ha)	23474	24878	23710	24257	23474	
	Net returns (Rs/ha)	20423	22377	18700	21320	17839	
	Benefit : Cost ratio	1.87	1.91	1.79	1.88	1.76	
Total productivity of rice-wheat system (kg/ha)		7053	7597	6819	7327	6644	
Percent increase over T_5		6.16	14.34	2.63	10.28	-	

Table 2. Effect of IPNS on yield and net returns under maize-wheat cropping system (Rajouri)

Year	Particulars	Treatment				
		T_1	T_2	T_3	T_4	C.D. (P=0.05)
2001-02	Maize yield (kg/ha)	3036	3532	3100	2882	145.3
	Wheat yield (kg/ha)	2596	2804	2600	2418	98.8
	Gross returns (Rs/ha)	32054	35886	32400	30127	
	Cost of cultivation (Rs/ha)	16438	18987	18409	16831	
	Net returns (Rs/ha)	15616	16899	13991	13296	
	Benefit : Cost ratio	1.95	1.89	1.76	1.79	
2002-03	Maize yield (kg/ha)	3106	3633	3230	2996	131.1
	Wheat yield (kg/ha)	2550	2900	2682	2354	104.8
	Gross returns (Rs/ha)	32105	37015	33583	30281	
	Cost of cultivation (Rs/ha)	16297	19380	18867	16823	
	Net returns (Rs/ha)	15808	17635	14716	13458	
	Benefit : Cost ratio	1.97	1.91	1.78	1.80	
2003-04	Maize yield (kg/ha)	3181	3703	3319	2951	130.0
	Wheat yield (kg/ha)	2776	2988	2708	2328	90.2
	Gross returns (Rs./ha)	33949	37937	34197	29887	
	Cost of cultivation (Rs/ha)	17321	19356	18687	16243	
	Net returns (Rs/ha)	16628	18581	15510	13644	
	Benefit : Cost ratio	1.96	1.96	1.83	1.84	
Mean	Maize yield (kg/ha)	3108	3623	3216	2943	
	Wheat yield (kg/ha)	2641	2897	2663	2367	
	Gross returns (Rs/ha)	32703	36946	33393	30098	
	Cost of cultivation (Rs/ha)	16685	19241	18654	16632	
	Net returns (Rs/ha)	16017	17705	14739	13466	
	Benefit : Cost ratio	1.96	1.92	1.79	1.81	
Total productivity of maize-wheat system (kg/ha)		5749	6520	5879	5310	
Percent increase over farmer's practice		8.26	22.79	10.72	-	

Table 3. Effect of IPNS on soil fertility changes after each rice-wheat crop cycle (Udhampur)

Year	Particulars	Treatment					
		T_1	T_2	T_3	T_4	T_5	C.D. (P=0.05)
2001-02	pH	6.4	6.5	6.5	6.6	6.5	NS
	Organic carbon (%)	0.40	0.49	0.45	0.47	0.44	0.01
	Available N (kg/ha)	204.8	213.5	203.5	208.8	200.4	0.17
	Available P (kg/ha)	18.8	20.1	18.6	19.3	18.2	0.17
	Available K (kg/ha)	189.2	193.7	188.0	195.4	182.0	0.87
2002-03	pH	6.4	6.5	6.5	6.5	6.5	NS
	Organic carbon (%)	0.37	0.52	0.48	0.50	0.47	0.02
	Available N (kg/ha)	208.8	222.1	208.1	215.2	198.0	1.69
	Available P (kg/ha)	19.3	20.5	19.0	19.7	17.8	0.27
	Available K (kg/ha)	192.2	199.9	191.0	197.4	180.4	2.07
2003-04	pH	6.5	6.5	6.6	6.6	6.6	NS
	Organic carbon (%)	0.40	0.54	0.50	0.52	0.48	0.02
	Available N (kg/ha)	213.4	228.0	208.2	220.1	197.4	3.22
	Available P (kg/ha)	20.0	21.2	18.5	20.4	17.6	0.38
	Available K (kg/ha)	196.8	205.8	191.4	201.6	181.6	2.41
Mean							
	pH	6.4	6.5	6.5	6.6	6.5	
	Organic carbon (%)	0.39	0.52	0.48	0.50	0.46	
	Available N (kg/ha)	209.0	221.2	206.6	214.7	198.6	
	Available P (kg/ha)	19.4	20.6	18.7	19.7	17.7	
	Available K (kg/ha)	192.7	199.8	190.1	198.1	181.3	

Initial values : pH = 6.5-6.8, O.C. = 0.43-0.46%, Av. N= 190.4-201.2 (kg/ha), Av. P=17.5-20.6 (kg/ha), Av. K. 175.3-182.4 (kg/ha).

Table 4. Effect of IPNS on soil fertility changes after each maize-wheat crop cycle (Rajouri)

Year	Particulars	Treatment				
		T_1	T_2	T_3	T_4	C.D. (P=0.05)
2001-02	pH	6.6	6.6	6.7	6.6	NS
	Organic carbon (%)	0.38	0.44	0.43	0.38	0.01
	Available N(kg/ha)	200.00	206.5	198.7	186.8	2.73
	Available P(kg/ha)	17.3	17.8	17.1	15.6	0.25
	Available K (kg/ha)	140.6	144.8	139.2	136.8	1.79
2002-03						
	pH	6.6	6.6	6.7	6.6	NS
	Organic carbon (%)	0.36	0.46	0.45	0.37	0.02
	Available N(kg/ha)	208.8	218.6	210.8	182.5	2.75
	Available P(kg/ha)	18.2	19.1	18.2	15.4	0.35
	Available K (kg/ha)	143.8	148.2	142.8	134.4	2.68
2003-04	pH	6.7	6.6	6.8	6.7	NS
	Organic carbon (%)	0.36	0.49	0.46	0.36	0.02
	Available N (kg/ha)	213.4	223.6	210.4	180.5	3.19
	Available P (kg/ha)	18.6	19.7	18.4	15.1	0.35
	Available K (kg/ha)	146.4	151.4	145.6	131.6	2.44
Mean						
	pH	6.6	6.6	6.7	6.6	
	Organic carbon (%)	0.37	0.46	0.45	0.37	
	Available N (kg/ha)	207.3	216.2	206.6	183.3	
	Available P (kg/ha)	18.0	18.9	17.9	15.4	
	Available K (kg/ha)	143.6	148.1	142.5	134.3	

Initial values : pH=6.5-6.8, O.C.=0.38-0.41%, Av. N=182-192 (kg/ha), Av. P=15.2- 16.1 (kg/ha), Av. K. 132-142 (kg/ha).

system was more remunerative than maize-wheat cropping system. Integrated plant nutrient supply in both system improved soil fertility appreciably (Table 3 and 4) but there was not much depletion of nutrients below the initial values in farmer's practice and 50% NPK treatments, which might have happened due to inherenet nutrient supply from soil to the system.

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EFFECT OF ENVIRONMENTS AND TIMING ON GRAFTING SUCCESS IN KIWI FRUIT

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Abstract

An experiment on Kiwi fruit grafting technique was undertaken to find out the optimum time and environmental conditions for maximum grafting success and satisfactory growth of prepared grafted plants. Tounge grafting was performed at 15 days interval starting from 30th December, 2004 to 15th February, 2005 under two environments *viz.*, open field and controlled polyhouse under Chaubattia climatic conditions. The maximum grafting success 66.0 percent and survival of grafts 87.2 percent were observed under polyhouse on 30th January, 2005. The success was 33.4 percent more under polyhouse than the open field condition. Date of grafting and environment had significant effect on shoot growth. The shoot growth and number of leaf size were 31.3 cm, 10.0 and 5.6cm more, respectively, under polyhouse as compared to open field.

Key words : Grafting, kiwi fruit, response.

Ripe Kiwifruits come in market in the month of November when other fresh fruits are not available and fetch very good price. Male and female flowers come on separate plants and essential to have atleast one male plant for every eight female plants to ensure good fruit setting. Pollination is mainly by bees and for commercial production the provision of beehives is essential. Being a new introduction and highly prized fruit, its plantation is increasing. Vegetatively propagated plants propagated plants bear fruits in early age of the plant, true to the type, therefore it is essential to propagate in mass scale to meet up the growers demand. Standard propagation techniques have attributed very good success. Carman (1980) ; Rathore (1984) ; Lal *et al.* (2001) have observed 40 to 68 percent success by hard wood cuttings and mound layering methods in open field condition. Under controlled polyhouse condition where optimum temperature and humidity prevailing in grafting season has not been assessed for maximum success of grafting so far in kiwi fruit. Keeping this in view, graft success under polyhouse, an attempt was made to find out the efficacy of environments and timing on the grafting success in kiwifruit through tounge grafting.

Materials and Methods

The present experiment was conducted at the Horticultural Research and Extension Centre, Chaubattia (Ranikhet), Almora during the year 2004-2005. Seedings of one year age having uniform growth were selected as rootstock for the grafting operation. Healthy bud stickes of uniform growth from current season growth were selected for grafting purposes at the time of grafting. Tounge grafting was performed at 15 days intervals from 30th December, 2004 to to 15th February, 2005 under open field and controlled condition (under polyhouse) where 27±4°C temperature and 80-90 per RH was maintained. The experiment was laid in R.B.D. comprising of graft were recorded 45 days and 110 days respectively after grafting operation. Shoot length, number of leaves per plant and leaf size were measured in October to find out accurate growth record.

Results and Discussion

The data presented in Table 1 show that the grafting success and shoot length were significantly influenced by different treatment. The maximum grafting success 66.0 percent and survival 87.2 percent were observed under polyhouse where controlled temperature and

Table 1. Grafting success in kiwifruit under polyhouse and open field conditions

Treatments	Number of grafts operated		Success (percent)		Survival (percent)		Length of shoot (cm)		Number of leaves		Leaf size (cm)			
											Length		Breadth	
	Poly-house	Open field	Poly-house	Open field	Poly-house	Open field	Poly-house	Open field	Poly-house	Open field	Poly-house	Open field	Poly-house	Open field
30th December	30	30	39.6	26.5	81.0	51.2	40.2	21.0	12.6	7.06	14.10	9.20	11.20	7.10
15th January	30	30	51.2	28.0	86.5	54.0	56.6	25.6	16.5	9.00	16.50	10.11	12.40	9.02
30th January	30	30	66.0	32.6	87.2	55.0	62.0	30.7	19.0	10.5	17.00	11.2	12.80	10.00
15th February	30	30	52.8	27.7	86.2	54.6	54.5	28.4	17.6	9.08	15.00	10.5	12.00	9.60
C.D. at 5%														
Timing	-	-	4.66	3.88	10.51	9.60	5.10	4.10	2.96	2.66	2.10	1.98	2.01	1.54
Environment	-	-	6.42	5.11	12.45	10.20	7.40	6.50	4.10	3.20	3.70	2.60	3.10	2.10
Interacting (Timing x Environment)	-	-	10.20	9.20	23.10	18.10	11.20	9.10	6.10	6.00	5.10	3.20	4.80	3.02

humidity were maintained. However, the grafting success 32.6 percent and survival 55.0 percent were observed under open field condition. The highest success and survival percent under polyhouse condition might be due to reasons of optimum temperature suitable for new parenchymetous callus proliferation between rootstock and scion (Hartmann *et al.* 1997) and for good callus formation due to higher humidity. These finding are also in conformity with the findings of Papalexandris (1982). The maximum shoot growth 62.0 cm and number of leaves 19.0 was observed under polyhouse as compared to 30.7 and 10.0 respectively in open field. The rapid shoot growth was observed in grafting between 30th January to 18th February, which might be due to favourable condition for shoot growth and enrichment of CO_2 level under polyhouse condition. Similar results were also observed by Chauhan and Sharma (1982) and Iqbal *et al.* (2004).

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SCREENING OF PROMISING CLONES IN EARLY CLONAL GENERATIONS FROM POOL OF *SACCHARUM COMPLEX* HYBRIDS

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ABSTRACT

Eighty four clones including three checks in first and second consecutive clonal generations were undertaken with the objective to identify reliable yield attributing traits for formulation of selection indices and selection of suitable clones in early clonal generation. A consistent trend for the significance of mean sum of square due to checks, entries, check vs. entries, range of variation and coefficient of variation was observed in both clonal generations. Correlation coefficient study revealed that only three quantitative traits i.e., number of shoots at 120 days, number of millable cane at harvest and single cane weight showed consistent trend of significant association with cane yield in both the clonal generations. Path coefficient analysis revealed that number of millable cane at harvest and single cane weight were major direct contibutor in both clonal generations. Multiple regression analysis revealed that single cane weight act as most reliable traits in predicting performance in early clonal generations. Preliminary selection in early clonal generation should be based on quantitative traits i.e. single cane weight, number of shoots at 120 days and number of millable canes and quality traits should be delayed to latter generation till the character stabilize.

Key words : Sugarcane, selection criteria, early clonal generation, correlation, path analysis, multiple regression.

Sugarcane is one of the most important cash crop in India. The importance of sugarcane increased tremendously in recent years, as Govt. of India decided to mix ethanol in suitable proportion to petroleum fuel. Plant breeder's responsibility has enhanced tremendously for genetic improvement of this crop to cope with changing ecological and economical necessity of country. Breeding cycle which usually takes 10 years i.e., from making crosses to final evaluation trial, can be shortened to much lower extent if breeders will be able to predict the promising genotypes in early stage of screening.

Thus, present investigation was conducted to predict the performance of genotype for yield and quality attributes in early clonal generation, with following objectives :

a) To study variability and association of quantitative traits with yield
b) To generate information on direct and indirect effects of yield and quality components in different clonal generations.
c) To identify reliable yield attributes for formulation of selection indices in early clonal generation and
d) To identify reliable clones in early clonal generation.

MATERIALS AND METHOD

In the present investigation, experimental materials consisting of eighty one clones with three checks i.e. BO110, BO128 and BO130 of sugarcane (*Saccharum complex* hybrids) were grown in augmented design in two consecutive clonal generation i.e., first clonal generation and second clonal generation during spring season of 2003-04 and 2004-05, respectively. The experimental materials were grown in research farm of Rajendra Agricultural University, Bihar, Pusa, Samastipur. In first clonal generation all experimental materials were planed in two rows of three meter long and ninety centimeter apart whereas in second clonal generation, all experimental materials were planted in four rows of six meter length and ninety centimeter apart. All the recommended package of practices for north Bihar condition were followed throughout the crop season.

Data were recorded for germination percent at 45 days, number of shoots per hectare at 120 days, number of millable canes per hectare, cane height at harvest, single cane weight, cane diameter at harvest, refract metric brix (in mix November, December and January, sucrose percent in juice in January), commercial cane sugar (CCS) percent in January and the cane yield. The mean data collected were subjected to statistical analysis for variance and variability were dind out. Correlation and path coefficient analysis were worked out as per the method described by Wright (1921) and Dewey and Lu (1959).

RESULTS AND DISCUSSION

Perusal of results revealed that there was consistent trend of significant variation for almost all the character in first and second clonal generation among eighty one entries except cane diameter at harvest and refractometric brix in mix December in second clonal generation and for sucrose percent in juice in first clonal generation Regarding ariation among check varieties, similar trends of significant at 45 days, number of shoots per hectare at 120 days, single cane weight, refractometric brix in mix November, CCS percent in January and cane yield (t/hec), however, the traits number of millable cane per hectare representing similar trend of non significant variation in both the generations. Remaining traits showed dissimilar trend of variation in either generations. The presence of substantial variability for agronomic and quality characters was reported by Nagarajan *et al.* (2000). Presence of variability in germination percent, shoots was also reported by Kamat and Singh (2001). The presence of variability in *et al.* (1999) reported ariability in CCS % in January.

This trend of variability was expected, as the entries are the crosses among highly heterozygous parents for most of the laci, such characteristics is the complex interaction of hereditary and environmental elements, as genes cannot be responsible for an observed character in absence of suitable environmental conditions for its to appear, nor can any association of environmental conditions alone cause a character to develop in absence of necessary genes.

The range of variation showed almost similar trend in both the clonal generations, for example the highest range of variation was observed for number of millable canes per hectare followed by cane yield, germination percent, number of shoot per hectare at 120 days etc in both the clonal generation. Almost similar trends were observed for coefficient of variation for all the traits in both clonal generations. In second clonal generation as comparison to first, a decrease in average mean for quantitative traits were recorded whereas it was more for quality traits. This trend of change in the mean performance of clones of first and second clonal generation for both qualitative and quantitative characters can rather be distinguished as "Settle down behaviour" as suggested by early workers (Hill, 1935).

Correlation coefficient for both quantitative and qualitative traits with cane yield and among themselves were studied (Table 1). The quality traits which showed positive significant correlation among themselves in both the clonal generations were : Refraetometric brix in mid November with refraetometric brix in mid December and mid January, sucrose percent in juice and CCS percent in January. Refractometric hi-bc in mid December with refractometrie brix in mid January. Refraetometrie brix in mid January found correlated with sucrose percent ii juice and CCS percent in January. Sucrose percent in juice was correlated with CCS percent in January. The significant negative association of brix in mid November and December with cane yield have changed in second clonal generation to non significant. While taking quantitative traits into consideration, three traits which showed positive significant correlation with yield in both the elonal generation were number of shoots at 120 days, number of millable

Table 1. Phenotypic correlation coefficient between pair of twelve quantitative characters (First and second clonal generation)

		X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
Characters	Generation	No.of shoots at 120 days	No.of millable canes	Cane height (cm)	Cane diameter (cm)	Single cane weight (kg)	Brix (mid Nov.)	Brix (mid Dec.)	Brix (mid Jan.)	Sucrose percent	CCS %	Cane yield
Germination Percent at 45 (X_1) days	I	0.482**	0.085	0.159	-0.238*	0.045	-0.095	0.033	0.125	0.325	0.277*	0.331**
	II	0.0027	0.00	-0.050	-0.201	-0.129	-0.039	-0.109	-0.098	0.077	0.064	-0.002
No. of shoots at (X_2) 120 days	I		0.247*	0.169	-0.104	-0.071	-0.217*	-0.141	-0.147	0.021	0.12	0.683**
	II		0.958**	0.184	-0.054	-0.013	-0.080	-0.020	-0.020	-0.022	0.019	0.791**
No. of millable (X_3) canes at harvest	I			0.299	-0.003	0.222*	-0.200	-.292**	-.292**	-0.179	-0.192	0.319**
	II			0.158	0.034	-0.061	-0.093	-0.028	-0.103	-0.108	-0.053	0.815**
Cane height at (X_4) harvest (in cm)	I				-0.227	0.079	-0.096	-0.167	-0.071	0.125	0.070	0.195
	II				0.112	0.045	-0.042	-0.004	0.178	0.152	0.117	0.137
Cane diameter at (X_5) harvest (in cm)	I					0.074	-0.053	-0.005	-0.042	-0.084	-0.064	-0.057
	II					-0.081	0.098	0.049	0.213	-0.131	-0.092	0.023
Single cane (X_6) weight (kg)	I						-0.140	-0.098	-0.008	0.178	0.195	0.558**
	II						0.202*	0.308**	0.236*	-0.088	0.095	0.238
Brix in mid Nov. (X_7)	I							0.865**	0.654**	0.418**	0.385**	-0.328**
	II								0.526**	0.259	0.229*	0.048
Brix in mid Dec. (X_8)	I								0.796**	0.457***	0.411**	-0.226*
	II								0515**	0.202	0.202	0.079
Brix in mid Jan. (X_9)	I									0.571**	0.512**	-0.151
	II									0.302**	0.219*	-0.029
Sucrose percent (X_{10}) in juice in Jan	I										0.956**	0.035
	II										0.917**	0.047
CCS% in juice in (X_{11}) Jan.	I											0.043
	II											0.087

*, ** : Denote significance at 5% and 1% probability level, respectively.

I & II : Denote first and second clonal generation, respectively cane at harvest and single cane weight. The component traits number of shoots at 120 days and number of millable canes were found positively and significantly correlated among themselves in both the clonal generations. The present finding of significant correlation of brix with commercial cane sugar (CCS) had also been reported by Battan *et al.* (1985), sucrose and CCS percentage were also reported to be positively correlated by Das *et al.* (1997). Puneet et al. (2002) also reported that the interrelationship between the quality traits was high and positive which supports present findings. Kumar and Singh (1999) had reported positive and significant correlation among yield vs among shoots at 120 days, whereas correlation among yield and number of millable cane was also reported by Rathesh and Varghese (1995). The component traits, number of millable canes per heetare and number of shoots at 120 days were also reported to be positively and significantly correlated by Kumar and Singh (1999).

Perusal at Table 2 revealed that only the single cane weight and the number of millable cane at harvest had positive direct effects towards cane yield in both clonal generation and out of these two traits, only the single cane weight was positive direct contributor in both clonal generation. Indirect effect of number of shoots per hectarc at 120 days via number of millable canes and cane height at harvest via number of millable canes was positive and more in second clonal generation. No consistent contribution of different qualitative and quantitative traits towards cane yield was observed in both the clonal generations. For instance, the trait, number of shoots per hectare at 120 days had positive direct and larger effect towards cane yield in first clonal generation whereas it was having negative little direct effect in second clonal generation, Similar ease was observed with other traits namely germination percent at 45 days , cane height, cane diameter and quality traits.

The present findings of positive direct effect of number of millable cane per hectare and single cane weight on cane yield was reported by various workers time to time viz. Balasundram and Bhagyalakshmi (1978), Hooda *et al.* (1988), Bakshi and Choudhary (2000) and Krishna and Singh (2004) etc.

The efficiency of multiple regression equation in present study for first and second clonal generation were observed to be same i.e r^2 (C_{11})=74.7, r^2 (C_{12})=72.7, r^2 (C_{21})=72.5 and r^2 (C_{22})70.8, where r^2 (C_{11}) and r^2 (C_{21}) were degree of determination for observed cane yield by taking all eleven characters in first and second elonal generation respectively and r^2 (C_{12}) and r^2 (C_{11}) were degree of determination of predicted cane yield by taking two characters (number of shoots per hectare at 120 days and single cane weight) in first clonal generation and three characters (number of millable cane per hectare, single cane weight and refractometric brix in mid November) in second clonal generation. These stated that efficiency of selection remained almost unaffected even after deleting nine characters in first clonal generation and eight character in second clonal generation.

Rank correlation between ranking of clones in both clonal generations based on selection indices were also remained strong as more than fifty percent of identified clones in first clonal generation and more then eighty percent of identified clones in second clonal generation were found quite closer in ranking in both the criteria. Top ten ranking clones of first clonal generation viz, CoXO212O, CoX02138, CoXO2IY7, CoX02244, CoX02129, CoX02027, CoXO2O5S, CoX02217, CoXO2O6l and CoXO2007 were found on the basis of eleven cane yield component characters. Top ten ranking clones after considering two cane yield cqmponent characters in first elonal generation were as follow: CoXO2117, CoXO2l2O, CoXO212I. CoX0231·4. CoX02027, CoXO2I3X, CoX02289, CoX02244, CoX02243 and CoXO2238 .Among the top ten ranking clones in first clonal generation CoX02117, CoXO2I2O. CoX02027, CoXO2I3S and CoX02244 were having almost similar ranking under both criteria.

Similarly, in case of second elonal generation top ten ranking cloncsn the basis of eleven component traits were CoX02217, CoXO2l77, CoXO2I82, CoXO2l50, CoX02058, CoX02148, CoX02001. CoX02307. CoX02176 and CoX02027

Table 2. Direct (Diagnol) and indirect effect of different quantitative characters towards cane yield in first (I) and second (II) clonal generation

		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
Characters	Generation	Germination percent	No.of shoots at 120 days	No.of millable canes	Cane height (cm)	Cane diameter (cm)	Single cane weight (kg)	Brix (mid Nov.)	Brix (mid Dec.)	Brix (mid Jan.)	Sucrose percent	CCS %	Cane yield
Germination	I	-0.0053	0.2916	0.0029	0.0059	0.0079	0.0222	0.0140	0.0004	0.0078	-0.0331	0.0175	0.3310**
Percent at 45 days (X_1)	II	0.0123	-0.0027	0.0000	0.0003	-0.0071	-0.0257	-0.0066	0.0104	0.0067	0.0102	-0.0002	-0.0020
No. of shoots at (X_2)	I	-0.0025	0.6050	0.0083	0.0063	0.0035	0.0350	0.0320	-0.0017	-0.0082	-0.0021	0.0076	0.6830**
120 days	II	0.0003	-0.986	0.9021	-0.0013	0.0019	0.0026	-0.0136	0.0019	0.0037	-0.0029	-0.0001	0.7910**
No. of millable (X_3)	I	-0.0040	0.1494	0.0336	0.0111	0.0001	0.1095	0.0295	-0.0036	-0.0164	0.0183	-0.0121	0.3190**
canes at harvest	II	0.0000	-0.0945	0.9416	-0.0011	0.0012	-0.0121	-0.0158	0.0027	0.0071	-0.0143	0.0001	0.8150**
Cane height at (X_4)	I	-0.0008	0.1022	0.0101	0.0372	0.0075	0.0390	0.0141	-0.0021	-0.0040	-0.0127	0.0040	0.1950
harvest (in cm)	II	-0.0006	-0.0181	0.1488	-0.0068	0.0040	0.0090	-0.0071	0.0004	-0.0122	0.0201	-0.0003	0.1370
Cane diameter at (X_5)	I	0.0013	-0.0629	-0.0001	-0.0085	-0.0332	0.0365	0.0078	-0.0010	-0.0024	0.0086	-0.0040	-0.0570
harvest (in cm)	II	-0.0025	-0.0053	0.0320	-0.0008	0.0355	-0.0161	0.0166	-0.0047	-0.0146	-0.0173	0.0003	0.0230
Single cane (X_6)	I	-0.0002	-0.0430	0.0075	0.0029	-0.0025	0.4933	0.0206	-0.0012	0.0004	-0.0182	0.0123	0.5580*
weight (kg)	II	-0.0016	0.0513	-0.0574	-0.0003	-0.0029	0.2490	0.0342	-0.0295	-0.0162	0.0117	-0.0003	0.2380*
Brix in mid Nov. (X_7)	I	-0.0005	-0.1313	-0.0067	-0.0036	-0.0018	-0.0691	-0.1474	0.0094	0.0367	-0.0426	0.0243	-0.3280**
	II	-0.0005	0.0079	-0.0876	0.0003	0.0035	0.0402	0.1694	-0.0828	-0.0361	0.0343	-0.0006	0.0480
Brix in mid Dec. (X_8)	I	-0.0002	-0.0853	-0.0098	-0.0062	0.0002	-0.0483	-0.1126	0.0123	0.0446	-0.0466	0.0260	-0.2260*
	II	-0.0014	0.0020	-0.0264	0.0000	0.0017	0.0613	0.1465	-0.0957	-0.0354	0.0267	-0.0005	0.0790
Brix in mid Jan. (X_9)	I	-0.0007	-0.0889	-0.0077	-0.0026	0.0014	0.0039	-0.0964	0.0098	0.0561	-0.0582	0.0324	-0.1510
	II	-0.0012	0.0053	-0.0970	-0.0012	0.0076	0.0470	0.0891	-0.0493	-0.0687	0.0400	-0.0006	-0.0290
Sucrose percent (X_{10})	I	-0.0017	0.0127	-0.0057	0.0047	0.0028	0.0878	-0.0616	0.0056	0.0320	-0.1020	0.0604	0.0350
in juice in Jan	II	0.0010	0.0022	-0.1017	-0.0010	-0.0047	0.0175	0.0439	-0.0193	-0.0207	0.1324	-0.0025	0.0470
CCS% in juice in (X_{11})	I	-0.0015	0.0073	-0.0065	0.0026	0.0021	0.0962	-0.0567	0.0050	0.0287	-0.0975	0.0632	0.0430
Jan.	II	0.0008	-0.0019	-0.0499	-0.0008	-0.0033	0.0189	0.0388	-0.0193	-0.0150	0.1214	-0.0027	0.0870

I & II : Denote first and second clonal generation, respectively. (Residual effect - first generation = 0.5071 & second generation = 0.5241) and top ten ranking clones on the basis of three yield components are CoXO2150, CoXO2 182, CoXO2 155, CoX02058, CoX02027. CoXO200 1, CoXO2 148, CoXO22 17, CoXO213O and CoX02177. Among the top ten ranking clones in second clonal generation CoXQ2 150, CoXO2 182, CoX02058. CoX02027, CoX02001, CoXO2 145, CoX02217 and CoX02177 were having almost similar ranking under both the eriterias.

Obviously, in the selection program stress on number of shoots per hcctarc at 120 days and single cane weight in first clonal generation will be easier to follow and equally rewarding than taking all eleven characters. Similarly stress given to the characters single cane weight, number of millable cane per hectare and refractometrie brix in mid November in second clonal generation will be easier to follow and equally rewarding than taking all eleven characters. The standard partial regression coefficient in both first and second clonal generation for single cane weight was high valued, while formulation of selection criterion by deducing non significant cane yield contributing traits so trend in third and subsequent elonal generation might be studied to get reliable results.

Bakshi and Choudhary (2000) reported number of millable canes or number of shoots as most reliable character for selection. Single cane weight was also reported as best criterion for selection in the breeding program by Bakshi and Kumar (1999). Similar observations was also reported by Krishna and Singh (2004) while studying genotypic variability in substropical sugarcane. Overall this study of two consecutive generations suggested that selection in early elonal generation should be done on the basis of single cane weight coupled with number of shoots at 120 days as well as number of millable canes. Single cane weight was most reliable trait for selecting genotypes in both the generations. The positive and significant correlation among number of shoots at 120 days and number of millable canes in both the generations advocated its inclusion in selection Procedure as these were among the major contributor to cane yield. Consideration of settling behavior of individual character is 3150 advocated to make selection more effective in early generations.

The changing behavior of correlation of brix in mid November and mid December with cane yield in both the generations and non significant association of other quality traits with cane yield advocate preliminary selection on the basis of cane yielding ability than to score these for juice quality. It can also be suggested that the scoring

Table 3. Mean performance of a top two identified genotypes of second clonal generation for all the twelve quantitative traits in both the generations

S.I.	Character	Genotypes					
		CoX02217		CoX02117		CoX0128	
		1st gen	2nd gen	1st gen	2nd gen	1st gen	2nd gen
1.	Germination percent at 45 days	43.33	42.52	66.53	45.75	31.56	32.88
2.	No. of shoot per hectare at 120 days (in thousand)	106.30	109.79	184.35	106.75	121.49	115.72
3.	No. of millable canes per hectare (in thousand)	96.78	96.49	101.51	97.63	101.86	110.49
4.	Cane height at harvest (in cm)	247	217	238	248	213	219
5.	Cane diameter at harvest (in cm)	2.27	2.86	2.67	2.39	2.16	1.89
6.	Single cane weight (in kg)	0.730	0.635	0.829	0.708	0.587	0.595
7.	Refractometric brix in mid November)	17.90	21.88	15.30	21.01	20.78	19.80
8.	Refractometric brix in mid December	19.16	20.49	18.56	22.02	21.64	20.82
9.	Refractometric in mid January	22.04	21.92	19.70	22.46	22.07	21.82
10.	Sucrose percent in juice in January	15.02	16.21	16.86	16.21	17.28	17.29
11.	CCS percent in juice in January	10.32	11.10	11.52	11.33	11.95	11.93
12.	Cane yield (t/ha)	66.82	66.17	78.87	65.64	59.60	59.41

of genotypes for quality traits should be delayed to later generation till the stabilize.

Finally, two clones, viz CoX02217 and CoX02177 were selected for subjecting directly for varietal evaluation trial and as parent in hybridization programme for improvement of subtropical sugarcane. Details about these two clones in compare to best check 30 128 were listed (Table 3).

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HETEROSIS STUDIES FOR EARLINESS AND SEED YIELD IN INDIAN MUSTARD (*BRASSICA JUNCEA* L. CZERN & COSS.)

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ABSTRACT

Heterosis was examined for earliness, days to 50 per cent flowering, number of primary branches, number of secondary branches, number of siliqua on main axis, number of seed per siliqua, days to maturity, biological yield and seed yield from the material generated from 12 x 12 diallel mating design of *Brassica juncea* (L.) Czern & Coss. Negative significant heterosis considered desirable for days to 50 per cent flowering and days to maturity. Highest heterosis was found in crosses IC-199715X EJ-3 (-21.03), Krishna X DIRA-313-6 (-2.89), EJ-2 X IC-199714 (60.42), EJ-2X IC-199714 (70.0), EJ-IX Pusa Agrani (37.96), EJ-3X RH-30 (34.88), EJ-2X EJ-1 (151.6) and Pusa Agrani X EC-28 (179.75) for days to 50 per cent flowering, days to maturity, number of siliqua on main axis, number of seed per siliqua, biological yield and seed yield, respectively.

Key words : Full diallel, heterosis, earliness, yield and mustard.

Among edible oil producing crops, rapeseed and mustard occupy second place to groundnut. It is cultivated in 5.4 million hectares area and production is 6.2 million tones (Anonymous, 2005). The yield level of the country is very low 1151 kg/ha as compared to the developed countries of the world which is very low. Form time immemorial, mustard is cultivated under moisture stress conditions and its productivity is restricted due to thermo-photo sensitivity, thereby affecting productivity. Insect pests and diseases also affect the productivity and oil content in seed. It has been proved by Singh and Murthy (1982), that the time taken from flowering to maturity directly affects the yield bearing capacity of the plant. The low yield level is also due to negative correlation primarily between biological yield and harvest index Singh and Srivastava, (1999). Rawat and Anand (1981) reported heterosis upto the extent of 22.6% for oil content. Teklewold *et al.* (2005) reported the significant heterosis for all the traits and seed yield showed the highest relative mid-parent heterosis that varied from 25 to 145 per cent with a mean of 67 per cent. Relative high-parent heterosis for seed yield varied from 16 to 124 per cent with a mean of 53 per cent.

In the absence of suitable restorer system in the available CGMS system, it is desirable to harness heterosis with two line system. It becomes imperative to examine the extent of heterosis available for further exploitation. Therefore the present study was undertaken involving 12 diverse parents and their F_1s.

MATERIALS AND METHODS

The present investigation was conducted J.V. College, Baraut (Baghpat), Division of Genetics and Seed Science & Technology, Indian Agricultural Research Institute, New Delhi during 2003-04 to 2005-06. The geographical location of experimental site is 28 ° 40'N. latitude 77 ° 10'E and 22816 m above mean sea level.

Twelve genetically diverse lines viz. EC-289602, DIRA-313-6, IC-199715, Agra local, Krishna, RH-30, IC-199714, Pusa Agrani, EJ-Zem-1, EJ-2 and EJ-3 were collected from different sources. All twelve parents were crossed in a full diallel mating and F_1's were sown in a randomized block design with three replication.

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Ten random selected plants were sampled from F_1, generation to record the observations namely days to 50 per cent flowering, days to maturity, number of siliqua on main axis, number of seed per siliqua, biological yield per plant (gm) and seed yield per plant (gm).

RESULTS AND DISCUSSION

Heterosis was calculated as per cent increase or decrease over better parental values for all studied eight characters (Tables 1 and 2).

Days to 50 per cent flowering indicated that the range of magnitude of heterosis lied between-21.61 per cent (IC-199715 X EJ-3) to 53.29 per cent. (EJ-1 X Zem-1). Twenty eight crosses showed heterosis in negative direction and one cross (Pusa Agrini X EJ-2) manifested significant heterosis over both the parents. It was earlier (46 days) than the earliest parent, EJ-1 (56.7 days). The days to maturity was observed that the range of magnitude of heterosis lied between-2.89 per cent (Krishna X DIRA-313-6) to 28.7 per cent. (Krishna X EC-289602). One cross showed heterosis in negative direction towards earliness and three crosses (EJ-3 X EJ-1). manifested significant heterosis over both the parents. It was earlier (115 days) than the earliest parent, EJ-1 (118 days).

For primary branches ninety two crosses showed heterosis in negative direction and thirty three revealed heterosis in desired positive direction. The data revealed that the range of magnitude of heterosis lied between-49.12 per cent (EJ-2 X EJ-3) to 60.42 per cent (EJ-2 X IC-199714) over better parents. The cross 13.43 percent (EJ-3 X Zem-1) manifested significant heterosis over both the parents. It was having more number of primary branches (12.67) than the highest number of primary branches parents Zem-1 (11.7). The range of number of secondary branches magnitude of heterosis lied between-41.05 per cent (EC-289602 X EJ-2) to 70.00 per cent (EJ- X IC-199714). Sixty seven crosses showed heterosis in negative direction and thirty four crosses observed heterosis over both the parents. There was number of secondary branches (41.67) than the highest number of secondary branches parent, EC-289602 (31.67).

Number of siliqua on main axis was showed negative in seventy three crosses and twenty five crosses observed heterosis in desired positive direction. The data revealed that the range of magnitude of heterosis lied beteween-44.44 per cent (Agra Local X IC-199714) to 37.96 per cent. (EJ-1 X Pusa Agrani). The cross (EJ-2 X RH-30) manifested significant heterosis over both the parents. There was the highest number of siliqua on main axis (74.67) than the number of siliqua on main axis over better parent EJ-2 (49.33). The results showed that the number of seed per siliqua range of heterosis lied between-37.25 per cent (EJ-1 X Pusa Agrani) to 34.88 per cent (EJ-3 X RH-30) and seventy five crosses showed heterosis in negative direction and forty eight crosses observed heterosis in desired positive direction. The cross (EJ-3 X RH-30) manifested significant heterosis over both the parents. There was the highest number of siliqua on main axis (74.67) than the number of seed per siliqua range of heterosis lied between-37.25 per cent (EJ-1 X Pusa Agrani) to 34.88 per cent (EJ-3 X RH-30) manifested significant heterosis in desired positive direction. The cross (EJ-3 X RH-30) manifested significant heterosis over both the parents. Its number of seeds per siliqua (19.33) was more than the better parent EJ-3 (14.33).

The performance of biological yield the heterosis of the crosses ranged from a minimum of-57.07 per cent (Krishna X Pusa Agrini) to 151.6 per cent (EJ-2 X EJ-1). Twenty four crosses showed heterosis in negative direction and forty eight crosses observed heterosis in desired positive direction. The cross (EJ-2 X EJ-1) manifested significant heterosis over both the parents. Here the biological yield per plant (4445.33 g) was than the highest biological yield per plant parents, EJ-2 (177.00 g). Seed yield per plant of thirty seven crosses showed heterosis in negative direction and ethic seven crosses observed heterosis in desired positive. The range of magnitude of heterosis lied between-51.98 per cent (Krishna X Agra Local) to 179.75 per cent (Pusa Agrini X EC-289602). The cross (Pusa Agrini X RH-30) manifested significant heterosis over both the parents. It seed yield per plant (113.67g) than the highest seed yield per plant parents, RH-30 (53.67g).

Table 1. **Five best significant cross combinations for per cent heterosis over parent for eitht characters in 12 x 12 diallel set of *Brassica juncea* Czern & Coss**

S.N	Best cross combinations	Heterosis (%)	S.N.	Best cross combinaions	Heterosis (%)
1	**Day to 50% flowering**		2	**Day to maturity**	
a	IC-199715 X EJ-3	-21.03	a	Krishna X DIRA-313-6	-2.89
b	IC-1997 X EC-289602	-19.55	b	EJ-3 X EJ-1	-2.54
c	IC-199715 X DIRA-313-6	-15.66	c	Pusa Agrani X EJ-1	-0.56
d	Pusa Agrani X EJ-2	-15.66	d	EJ-IX Pusa Agrani	-0.28
e	IC-199715 X IC-199714	-15.58	e	IC-199715 X RH-30	0
3	**Number of primary Branches**		4	**Number of secondary branches**	
a	EJ-2 X IC-199714	60.42	a	EJ-2 X IC-199714	70
b	EJ- X Pusa Agrani	41.67	b	EJ-3 X RH-30	46.97
c	Agra Local X EC-289602	41.33	c	IC-199715 X Zem-1	39.19
d	EC-289602 X Krishna	38.46	d	EJ-3 X Krishna	38.71
e	Krishan X EJ-2	35.90	e	EJ-3 X IC-199715	38.71
5	**Number of siliquae on main axis**		6	**Seeds per siliqua**	
a	EJ-1 X Pusa Agrani	37.96	a	EJ-3 X RH-30	34.88
b	DIRA-313-6 X Agra local	36.8	b	Pusa Agrani X RH-30	24.39
c	Krishna X EJ-2	30.41	c	IC-199715 X IC-199714	23.08
d	Krishna X Agra Local	22.92	d	Agra Local X Zem-1	20.51
e	Agra Local X Pusa Agrani	21.95	e	Zem-IX EJ-3	18.60
7	**Biological yield/plant (gm)**		8	**Seed yield per plant**	
a	EJ-2 X EJ-1	151.6	a	Pusa Agrani X EC-289602	179.75
b	Pusa Agrani X RH-30	98.94	b	EC-289602 X Zem-1	156.99
c	IC-199714 X RH-30	98.64	c	EJ-1 X Pusa Agrani	142.22
d	EC-289602 X Pusa Agrani	95.43	d	EC-289602 X Pusa Agrani	137.97
e	Agra Local X EJ-1	85.71	e	Pusa Agrani X Zem-1	135.48

Table 2. Estimates of heterosis for eight characters in 12 x 12 diallel set of *Brassica juncea* Czern & Coss

S.N.	Crosses	% heterosis over better parent (BP)							
		Days to 50% flowering	Days to maturity	Primary branches (Nos.)	Secondary branches (Nos.)	Siliquae on main axis (Nos)	Seeds per siliquae (Nos.)	Biological yield/ plant(gm)	Seed yield /plant (gm)
1	EC-289602 X DIRA-313-6	-2.79	18.55**	-6.98**	-3.16	-4.58	-22.00**	81.31**	60.63**
2	X IC-199715	1.68	18.55**	16.22*	-7.37**	-16.46**	-4.00**	22.10*	14.86**
3	X Agra local	3.41*	9.86**	38.46**	12.63**	-14.58**	-6.00**	-15.88	16.34**
4	X Krishna	-3.35*	4.64**	38.46**	-3.16	-14.58**	-6.00**	-15.88	16.34**
5	X RH-30	3.91*	16.52**	-6.38**	-22.11**	-30.62**	-4.00**	63.79**	38.51**
6	X IC-199714	-9.50**	10.75**	11.11**	-17.89**	-11.11**	-16.00**	-11.47	-31.91**
7	X Pusa Agrani	13.25**	4.6**	25.71**	-6.32**	17.56**	2.00**	95.43**	137.97**
8	X EJ-1	9.87**	2.32	25.00**	-32.63**	6.57*	-9.00**	18.47	18.89**
9	X Zem-1	21.79**	18.26**	-44.78**	-40.00**	-28.65**	-18.00**	12.40	156.99**
10	X EJ-2	5.88**	4.64**	-18.42**	-41.05**	8.11**	-12.00**	1.88	-16.79**
11	X EJ-3	0.00	10.72**	-26.37**	-25.26**	-4.58	2.00**	-23.62*	-10.28**
12	DIRA-313-6X EC-289602	10.06**	5.00**	0.00	-25.26**	11.45**	2.00**	-42.06**	-38.56**
13	X IC-199715	-1.52	3.91**	11.63**	4.62	9.76**	-10.00**	-16.41	-19.43**

14	X Agra local	9.09**	4.62**	-4.44**	4.62	36.80**	-10.00**	11.41	-9.15**
15	X Krishna	-0.51	0.44	-2.33**	-16.92**	-1.39	-16.00**	-16.39	10.89**
16	X RH-30	1.52	1.35	-14.89**	7.58**	-11.88**	6.00**	35.66**	34.16**
17	X IC-199714	-5.05**	2.14	-11.63**	4.62	-21.11**	-6.00**	12.13	26.80**
18	X Pusa Agrani	13.86**	15.28**	-16.28**	-18.46**	16.80**	-26.00**	19.97	40.52**
19	X EJ-1	19.08**	11.94**	16.67**	-3.08	3.65	-7.84**	-13.55	-6.54**
20	X Zem-1	13.13**	-25.37**	-25.37**	29.73**	3.12	-4.00**	-24.90*	-25.49**
21	X EJ-2	-1.76	-2.33	-2.33**	13.85**	-3.38	10.00**	14.27	10.46**
22	X EJ-3	-4.62**	-29.82**	-29.82**	10.77**	-12.60**	-12.00**	26.39*	58.17**
23	IC-199715 X EC-289602	-19.55**	0.00	0.00	-40.00**	-18.29**	6.00**	0.61	-9.71**
24	X DIRA-3136	-15.66**	16.28**	16.28**	-18.46**	3.66	-22.00**	39.94**	46.29**
25	X Agra local	-3.41*	-4.44**	-4.44**	14.29**	-19.51**	7.69**	32.18**	45.74**
26	X Krishna	-4.98**	7.69**	7.69**	0.00	00	-17.02**	27.66*	-14.85**
27	X RH-30	-6.90**	-31.91**	31.91**	-19.70**	-15.85**	15.38**	38.18**	46.86**
28	X RH-199714	-15.58**	13.51**	13.51**	23.33**	23.33**	20.08**	31.25**	29.71**
29	X Pusa Agrani	6.63**	-21.62**	-21.62**	-15.00**	-18.90**	14.63**	8.38	8.57**
30	X EJ-1	16.45**	15.14**	15.14**	-3.08	-25.61**	-7.84**	33.23**	29.71**
31	X Zem-1	-10.84**	-30.15**	-30.15**	39.19**	-16.67**	12.82**	0.01	10.86**
32	X EJ-2	-0.59	20.53**	20.53**	0.00	-34.15**	2.13**	17.53	22.29**
33	X EJ-3	-21.03**	-36.84**	-36.84**	-12.90**	-37.80**	-16.28**	55.64**	53.14**
34	Agra Local X EC-289602	-14.77**	41.33**	41.33**	31.58**	2.29	-12.00**	82.86**	114.91**
35	X DIRA-313-6	6.82**	13.78**	13.78**	24.62**	7.20*	-30.00**	38.37**	-13.07**
110	X EJ-3	7.69**	18.64**	-22.39**	1.35	-2.08	18.60**	-15.60	108.41*
111	EJ-2 X EC-289602	-7.06**	4.64**	10.53**	-34.74**	-22.97**	12.00**	-3.20	-10.95**
112	X DIRA-313-6	7.65**	12.40**	-6.98**	-1.54	-22.97**	0.00	17.12	58.17**
113	X IC-199715	7.06**	10.43**	-5.26**	-6.67**	-31.10**	8.51**	2.29	-10.29**
114	X Agra Local	-5.29**	7.54**	-2.22**	3.17	-7.43*	14.89**	-20.90	-11.68**
115	X Krishna	5.88**	8.12**	-23.08**	-1.67	-8.78**	12.77**	30.74**	65.84**
116	X RH-30	9.41**	11.59**	-25.53**	-12.12**	-21.88**	-4.26**	38.33**	19.88**
117	X IC-199714	5.29**	8.14**	60.42**	70.00**	-10.00**	-6.38**	51.37**	83.69**
118	X Pusa Agrani	12.05**	2.70	-21.05**	13.33**	-11.49**	8.51**	27.12*	18.25**
119	X EJ-1	3.95*	3.19*	0.00	-6.15**	-1.35	-23.53**	151.60**	110.95**
120	X Zem-1	24.12**	16.52**	-37.31**	17.57**	-21.88**	2.13*	-2.50	67.88**
121	X EJ-3	1.76	3.19*	-49.12**	-4.84*	-21.62**	8.51**	6.21	0.73
122	EJ-3 X EC-289602	-11.73**	8.70**	-19.30**	-12.63**	-1.53	2.00**	38.29**	123.36**
123	X DIRA-313-6	-10.77**	9.80**	-33.33**	-27.69**	0.79	6.00**	48.64*	45.10**
124	X IC-199715	-6.15**	5.65**	-24.56**	38.17**	-34.15**	6.98**	8.08	-2.29
125	X Agra Local	3.98*	4.52**	-26.32**	17.46**	-3.94	-4.65**	-9.77	66.67**
126	X Krishna	-2.05	11.58**	-26.32**	38.71**	13.19**	2.13**	5.74	36.63**
127	X RH-30	-3.59*	12.99**	-12.28**	46.97**	-16.88**	34.88**	14.39	5.59*
128	X IC-199714	-3.59*	9.60**	-31.58**	-3.23	-20.56**	-11.63**	3.94	21.28**
129	X Pusa Agrani	2.41	1.69	-26.32**	9.60**	-1.57	9.30**	74.77**	108.41**
130	X EJ-1	19.74**	-2.54	-22.81**	-3.08	13.14**	-11.76**	12.84	83.18**
131	X Zem-1	16.41**	19.49**	13.43**	13.54**	-3.65	4.65**	-13.60	104.67**
132	X EJ-2	8.24**	2.90*	-21.05**	11.29**	-4.05	8.51**	30.13**	10.95**
	S.E.d	1.63	138	0.34	2.44	3.30	0.71	10.97	2.49
	C.D. 5%	3.19	2.70	0.67	4.78	6.47	1.39	21.50	4.88
	C.D. 1%	4.19	3.55	0.87	6.27	8.48	1.82	28.19	6.40

*,** Significant at 5% and 1% level, respectively

In the present study, best cross combination have been selected based on heterosis over the better parents. Available literature revealed yield heterosis of more than 200 per cent in Indian mustard (Labana *et al.*, 1975; Banga and Labana, 1984). The occurrence of increased seed yield in F_1 hybrids over better and mid-parental values has a direct bearing on increasing the production of Indian mustard. Such an increased performance may be due to additive and additive X additive interaction and/or non-additive type of gene actions. Breeders can exploit only fixable components of genetic variability in autogamous crops like.

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EFFECT OF SCARIFICATION TREATMENTS ON HARDSEEDEDNESS IN TWO WILD SPECIES OF *CORCHORUS*

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Abstract

The effect of various scarification treatments on hardssedeness of two wild species of *Corchrus* was studied. Increased germination was recorded using acid scarification for 10 minutes and hot water treatment at 80 °C for 3 minutes and 5 minutes in *C. tridens* whereas concentrated acid treatment for 40 minutes in *C. trilocularis*. Subjecting seeds to dry heat was found ineffective in removing hardseededness.

Key words : *Corchorus,* wild species, scarification and germination.

Jute is one of the most important fiber crops, second only to cotton in importance. India and Bangladesh account for about 95% of world jute production. Jute is obtained from two cultivated species of genus *Corchorus* (family Tiliaceae) *viz.* C. *capsularis* and *C. olitorious.* Genus *Corchorus* has 38 recognized wild species of which only nine are found in Indian sub-content. Wild species are sources of desirable genes in any crop improvement programme but the precise use of these wild species in future breeding cannot be determined until they are collected and grown and their compatibility with cultivated strains assessed. Keeping this in view wild species of jute were collected under NATP (PB). While testing the viability of seeds of *Corchous tridens and Corchorus,* received from Central Research Institute of Jute Allied Fibres (CRIJF), Barrackpore for long term conservation in NGB. It was observed that seed of both the species exhibited hardseedness ranging from 99-100%. In nuture, hardseededness is of significant ecological benefit as it helps to overcome unfavorable conditions thereby multiplying chances of establishment (Serrto-Valenti *et al,* 1986). However in agriculture hardseededness can be disadvantageous, as the lack of simultaneous germination prevents uniform stand establishment (Riggio Bevilaqua *et al.,* 1985) in the field. Seed dormancy is a serious problem in genebanks as it can often interfere with the results of germination tests designed to estimate the percentage viability of accessions. Dormancy is not a problem in cultivated species but the seeds of wild species viz., *C. aestuans, C. depressus,* and *C. trilocularis* show hard seeds (Chawan and Sen, 1973). Treatments devised to break the dormancy are highly specific because a seed population sample shows distinct differences in the seed coat impermeability. The purpose of this study was to evaluate the efficacy of the fuse of sulphuric acid and hot water treatment in breaking hardseededness in two wild *Corchorus* species, *C. tridens* and *C. trilocularis,* both of which have high natural hard seed levels.

Materials and Methods

Physiological mature seeds of C. tridens (IC 382009) and *C. trilocatlaris* (IC 382059) were received form CRIJAF, Barrackpore for long term conservation in NGB. Seed of both the species exhibited 99-100% dormancy due to hard seed. Therefore, the sample were subjected to following treatments during 2005.

Acid Scarification : Seed were immersed in concentrated sulphuric acid (H_2SO_4) for 5, 10, 15, 20, 30, 40 mins and 50% sulphuric acid (H_2SO_4) for 40 and 60 minutes. After the treatment seeds were thoroughly washed in running tap water for 2-3 hours before planting.

Hot Water Treatment : Seed were subjected to hotwater for varying temperatures and durations as follows

(a) at 75 °C for 15 and 30 minutes, and
(b) at 80 °C for 3,5 and 10 minutes.

Dry heat treatment : Seeds were subjected to dry heat at 65 °C for 17 hours in forced drought air oven.

Seed Germination test : Germination test was performed using 4 replicates of 50 seeds each (30 °C, 10 days, top of paper). Evaluation of normal seedlings, abnormal seedlings, hard and dead seeds followed agreed methods (ISTA, 2003). The data was subjected to statistical analysis in randomized complete block design using MSTATC software. The data recorded as percentage were angular transformed to the before subjecting them to statistical analysis.

RESULTS AND DISCUSSION

Horticulturists, foresters, farmers, gardeners and researchers have developed various techniques that can make impermeable seed coat to imbibe water. Their techniques include use of scarification either by acid, mechanical, chemical, enzymatic action. Precurssions, dry heat, hot water, rapid freezing, radiation and thawing. Treatments such as mechanical and acid scarification will almost always make a seed permeable to water, but the success of other methods varies with the species and treatment duration. Seed scarification using concentrated sulphuric acid and hot water treatment have been widely used with conditionable success on many species. In the present study also, acid scarification and hot water treatment were more significant as compared to dry heat treatment. In present study, only fifty percent success was obtained in both the species. In *Ctridens,* percentage hard seed declined significantly with each 5 minute increase in immersion time in sulphuric acid as well as in hot water, with increase in germination percentage, until after 15 minutes of acid immersion (Tables 1 and 2) Higher durations of acid scarification simultaneously increased the dead seed percentage in *C.tridens.* Acid scarification for 40 minutes in *C.triloculris* was most successful. Hot water treatment was insignificant in case of *C.trilocularis* was most successful. Hot water treatment was insignificant in case of *C.trilocaularis* but in case of *C.tridens,* exposure to 80 °C for 3 and 5 minutes gave 54-55% normal seedlings as against 9% in control.

Several investigators working with different crops have employed various treatments for breaking hardseededness. Methods of softening hard seeds have been described by Porter (1949) and Bisland *et al.,* (1984). Sulphuric acid treatment is a well recognised and effective method of softening impermeable seed (Quinlivan, 1971). The efficacy of H_2SO_4 treatment has been reported in *Strophostyle helvola, Coronilla varia, Circis candanesis* and *Colutea istria* by Rolston (1978), in *Lupinus cosentine* (Horn and Hill 1974), in *Lotus uliginosus* by Hare and Rolston (1985), in *Vigna mungo* by Tomar and Promila (1991) and Kalyani *et al.,* (1997) in *Corchorus olitorius* and *C.capsularis.*

Beneficial effects of hot water treatment have been reported by many workers as in cotton (Patil and Andrews 1984), *Acacia catechu,* 80 °C for 1 minute, *A. decureens, A. leucopholea* and *A. auriculiformis* 100 °C for 1 minute (Karihaloo, 1984). Similarly enhanced germination was recorded in *Abutioln indicum* with hot water scarification (Gupta *et al.,* 2001).

Thus from the results obtained in the present investigation, it is clear that the two wild species of *Corchorus* respond in significantly different manner to the various treatments employed for softening the seed coat. Also, the results indicate that the use of concentrated sulphuric acid for softening the seed coat. Also, the results indicate that the use of concentrated sulphuric acid for 10 minutes hot water treatment at 80 °C for 3 minutes and 5 minutes in *C.tridens* whereas concentrated acid treatment in *C.trilocularis* were significantly effective in softening the impermeable seed coat. Thus, these treatments can be employed by genebank staff for routine seed testing during seed conservation programmes.

Table 1. Effect of Acid Scarification on seed germinatio of *Corchorus* species

	Normal		Abnormal		Hard		Dead	
Duration (MIN)	*C.tridens*	*C.trilocularis*	*C.tridens*	*C.trilocularis*	*C.tridens*	*C.trilocularis*	*C.tridens*	*C.trilocularis*
100% Acid Scarification								
5	42.195	4.050	13.575	5.313	43.323	86.885	17.077	4.054
10	54.955	7.363	11.460	4.050	20.580	84.643	26.882	4.054
15	51.032	9.888	7.363	4.050	6.575	82.033	38.148	4.050
20	25.490	7.993	7.993	4.049	4.050	83.948	62.108	4.051
30	16.415	30.880	6.577	4.050	12.798	58.468	67.895	8.625
40	6.575	57.135	6.575	4.050	4.050	28.662	83.705	11.375
50% Acid Scarification								
20	9.413	11.375	4.050	4.050	82.400	80.185	4.058	4.050
40	16.930	18.705	4.050	4.050	68.913	71.530	4.050	6.100
60	21.172	26.460	5.313	5.313	65.440	61.480	9.888	11.305
Control	9.10	9.10	4.050	4.050	82.97	82.97	4.050	4.050
C.D. at 5%								
V	2.63		1.48		3.44		2.53	
T	5.54		3.21		7.3		5.37	
VXT	7.7		4.49		10.3		7.43	

Table 2. Effect of Hot Water Scarfication on seed germination of *Corchorus* species

	Normal		Abnormal		Hard		Dead	
Duration (MIN)	*C.tridens*	*C.trilocularis*	*C.tridens*	*C.trilocularis*	*C.tridens*	*C.trilocularis*	*C.tridens*	*C.trilocularis*
75 °C								
15	12.00	15.175	7.363	6.553	73.195	74.875	10.043	4.050
30	19.588	18.957	10.043	8.625	66.920	64.113	9.888	16.160
80 °C								
3	55.410	18.650	6.100	6.575	33.410	57.490	8.750	11.305
5	54.840	31.392	10.043	8.625	29.630	54.162	18.575	18.488
10	27.487	22.625	11.305	11.850	11.305	47.318	56.520	32.070
Control	9.10	9.10	4.050	4.050	82.97	82.97	4.050	4.050
C.D. at 5%								
V	2.63		1.48		3.44		2.53	
T	5.54		3.21		7.33		5.37	
VXT	7.77		4.49		10.3		7:43	

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VARIABILITY STUDIES IN SEGREGATING POPULATIONS OF RICE (*ORYZA SATIVA* L.)

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ABSTRACT

Genetic parameters were studied in a set of thirteen parental lines and thirty F_2 populations in transplanted rice. For all the characters, the estimates of GCV were smaller than that of PCV, suggesting the influence of environment on them. High heritability coupled with high genetic advance for filled grains panicle^{-1}, harvest index, grain yield panicle^{-1}, productive tillers plant^{-1} and biological yield plant^{-1} indicated that these characters were predominantly governed by additive gene action and improvement for these characters could be brought about by direct selection. High heritability with moderate to low genetic advance for days to 50% flowering, panicle length, spikelet fertility and 1000-grain weight suggested the predominant role of non-additive gene action in their inheritance and selection for these characters must be taken up in advance generations.

Key words : Rice, genetic parameters, yield components, segregating generations.

Rice (*Oryza sativa* L.) is the principal food crop of India but the ever increasing population, stresses the need to increase the productivity of rice. Grain yield is a complex character and it is the resultant expression of several interrelated polygenic characters. Grain yield is poorly responsive to selection and it is, therefore imperative to obtain information on different genetic parameters of the characters influencing grain yield. This will help in formulating suitable selection criteria for the genetic improvement of yield. The study of genetic variability in the segregating generations from where the actual selection is made may be more useful to the breeder. The present investigation was therefore, undertaken to assess the magnitude of variability and to understand the heritable component of variation for yield and yield components in transplanted rice.

MATERIALS AND METHODS

Thirty F_2 populations of rice along with their thirteen parental genotypes *viz.*, IET 13846, IET 15391, IET 11819, Pusa Basmati-1, Kasturi, Basmati 370, Mahi Sugandha, Pakistani Basmati, IR 64, Ratna, Suraksha and Narendra 359 were planted in a randomized block design with three replications at Agricultural Research Station, Kota (Rajasthan) during wet season, 2002. Twentyfive days old seedlings were transplanted in each plot consisting of fifteen rows of 5.0 m length with a spacing of 20 x 15 cm between rows and plants. The standard package of practices were adopted to raise the healthy crop. Ten plants from parental lines and twenty plants from F_2 populations were randomly selected from each treatment in each replication for recording observations on 13 characters *viz.*, days to 50% flowering, days to maturity, plant height, productive tillers plant-1, panicle length, filled grains panicle^{-1}, unfilled grains panicle^{-1}, spikelet fertility (%), biological yield plant^{-1}, harvest index, 1000-grain weight, grain yield panicle^{-1} and grain yield plant-1. The mean values were used separately for the analysis of variance. The genotypic and phenotypic coefficients of variability (GCV and PCV) were calculating following the method of Sigh and Chaudhary (1985). Heritability (broad sense) and expected genetic advance as per cent of mean were estimated as suggested by Johnson *et al.*(1955).

RESULTS AND DISCUSSION

The analysis of variance for parents and F_2 progenies revealed highly significant differences among the genotypes for all the characters studied, indicating the existence of enormous variability in the experimental material. Data on mean, variability, heritability and genetic advance are presented separately for parents and F_2 progenies in Tables 1 and 2. The estimates of GCV were smaller than that of PCV for almost all the characters, indicating some influence of environment on them. However, relatively small differences between GCV and PCV for these characters indicated that these were mostly governed by the genetic factors. Among parents, GCV was highest for filled grains panicle^{-1} (23.06%) followed by harvest index (22.73%), grain yield panicle^{-1} (17.92%), productive tillers plant^{-1} (16.69%), plant height (15.47%) and grain yield plant-1 (15.29%). In F_2 population, maximum GCV was observed for harvest index (28.42%) followed by filled grains panicle^{-1} (24.37%), biological yield plant^{-1} (20.68%), grain yield panicle^{-1} (19.22%), productive tillers plant^{-1} (18.43%) and grain yield plant^{-1} (16.46%). The phenotypic coefficients of variation (PCV) followed almost similar trends in both the populations. Similar findings were also reported by Chakraborty and Hazarika (1994), Birbira and Hazarika (1998), Das *et al.* (2001), Agarwal (2003) and Panwar (2005).

Heritability was high for all the characters ranged from 94.23 per cent for days to maturity to 100.00 per cent for filled grains panicle^{-1} in parental lines and from 97.30 per cent for panicle length to 100.00 for filled grains panicle^{-1} and biological yield plant^{-1} in F_2 population. Heritability in broad sense includes additive and epistatic gene effect, and hence it will be reliable only if accompanied by high genetic advance. Johnson *et al.* (1955) pointed out that w3ithout genetic advance, the estimates of genetic heritability will not be of much value for selection of phenotypic performance, they suggested that genetic gain should also be considered along with heritability estimates for the selection-based genetic improvement of a character.

In the present investigation, high heritability coupled with high genetic advance was observed for filled grains panicle^{-1}, harvest index, grain yield panicle^{-1}, productive tillers plant^{-1}, plant height and grain yield plant^{-1} in

Table 1. Range, mean and genetic parameters for grain yield and its components in parental lines of rice

S. No.	Characters	Range	Mean + SEm	Genetic parameters			
				Genotypic coefficient of variation (GCV)	Genotypic coefficient of variation (PCV)	Heritability (bs)	Genetic advance (% of mean)
1.	Days to 50% flowering	98.67-108.33	103.41-0.34	3.01	3.06	96.55	6.09
2.	Days to maturity	132.33-139.33	135.21-0.34	1.76	1.81	94.23	3.52
3.	Plant height (cm)	79.978-128.93	101.90-0.18	15.47	15.17	99.96	31.86
4.	Productive tillers plant^{-1}	10.93-19.50	13.15-0.12	16.69	16.76	99.13	34.22
5.	Panicle length (cm)	24.87-28.90	27.50-0.19	5.09	5.23	94.66	10.20
6.	Filled grains panicle^{-1}	99.90-211.93	137.74-0.12	23.06	23.06	100.00	47.51
7.	Unfilled grains panicle^{-1}	16.83-37.87	24.59-0.14	12.49	12.53	99.67	25.64
8.	Spikelet fertility (%)	79.60-88.73	84.88-0.08	3.01	3.01	99.67	6.19
9.	Biological yield plant^{-1} (g)	73.27-124.33	98.22-0.09	14.22	14.22	99.99	29.30
10.	Harvest index (%)	18.97-40.83	27.61-0.12	22.73	22.74	99.89	46.80
11.	1000-grain weight (g)	21.00-26.20	23.64-0.09	6.13	6.16	98.97	12.56
12.	Grain yield panicle^{-1} (g)	1.50-2.68	2.00-0.03	17.92	18.11	97.94	36.53
13.	Grain yield plant^{-1} (g)	18.93-29.90	25.81-0.10	15.29	15.31	99.80	31.47

Table 2. Range, mean and genetic parameters for grain yield and its components in F_2 population of rice

S. No.	Characters	Range	Mean + SEm	Genotypic coefficient of variation (GCV)	Phenotypic coefficient of variation (PCV)	Heritability (bs)	Genetic advance (% of mean)
1.	Days to 50% flowering	92.33-112.33	101.88-0.33	5.69	5.72	99.04	11.66
2.	Days to maturity	126.67-144.33	135.27-0.34	3.72	3.75	98.67	7.61
3.	Plant height (cm)	74.03-123.93	97.81-0.19	11.55	11.55	99.92	23.78
4.	Productive tillers plant^{-1}	10.87-19.93	15.12-0.13	18.43	18.49	99.32	37.83
5.	Panicle length (cm)	21.97-29.93	27.21-0.17	6.53	6.62	97.30	13.28
6.	Filled grains panicle^{-1}	92.87-220.77	153.14-0.12	24.37	24.37	100.00	50.20
7.	Unfilled grains panicle^{-1}	10.97-38.27	23.21-0.14	11.78	11.83	99.58	24.16
8.	Spikelet fertility (%)	75.23-94.53	86.44-0.09	4.78	4.79	99.86	9.85
9.	Biological yield plant^{-1} (g)	60.77-140.00	97.00-0.08	20.68	20.68	100.00	42.59
10.	Harvest index (%)	16.30-41.93	27.51-0.11	28.42	28.42	99.94	58.52
11.	1000-grain weight (g)	17.17-25.13	22.26-0.09	8.72	8.75	99.34	17.90
12.	Grain yield panicle^{-1} (g)	1.12.63	1.71-0.03	19.22	19.46	97.55	39.11
13.	Grain yield plant^{-1} (g)	17.93-32.83	25.51-0.11	16.46	16.47	99.81	33.87

parental lines whereas maximum estimates were recorded for harvest index, filled grains panicle^{-1}, biological yield plant^{-1}, grain yield panicle^{-1}, productive tillers plant^{-1} and grain yield plant^{-1} in F_2 population, indicated that these characters were predominantly governed by the additive gene action. These characters could be improved by mass selection and other breeding methods based on progeny testing. These results are in accordance with earlier findings of Ramalingam *et al.* (1994), Mehetra *et al.* (1994), Chauhan (2003) and Panwar (2005).

High heritability associated with moderate to low genetic advance was found in respect of days to 50% flowering, panicle length, spikelet fertility and 1000-gtain weight in both the populations, suggesting the greater role of non-additive gene action in their inheritance and selection in later generation would be more effective, confirming the earlier reports of Agarwal (2003), Chauhan (2003) and Panwar (2005).

An overall consideration of results revealed that grain yield plant^{-1} could be improved through selection for filled grains panicle^{-1}, harvest index, grain yield panicle^{-1}, productive tillers plant^{-1} and biological yield plant^{-1}. Days to 50% flowering, panicle, spikelet fertility and 1000-grainweight had high heritability but comparatively low genetic advance and therefore, selection for these characters will have to be carried in advance segregating generations.

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EFFECT OF GAMMA IRRADIATION OF SEEDS ON GROWTH, SEX EXPRESSION AND YIELD IN BOTTLE GOURD (*LAGENARIA SICERARIA* STANDL.)

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Abstract

In the present study, bottle gourd seeds of variety Pusa Summer Prolific Long were treated with gamma rays at different doses of 0.5, 0.75, 1.0, 1.25, 1.5, 1.75, and 2.0 k Rad. It was observed that I k Rad of gamma radiation is the most effective dose for inducing better growth, sex expression and yield of fruit in bottle gourd. However, the gamma radiation doses were found to have harmful effect on the germination. The germination percentage decreased with increasing doses of gamma irradiation.

Key words : Bottle gourd, gamma irradiation, seed quality, sex expression, yield.

Induced mutagenesis has been successfully used to generate variability and to improve cultivars for certain specific traits in a large number of crops. Ionizing radiations are now playing a significant role in inducing variations and in this respect, gamma irradiation is widely used. Generally, a higher dose of gamma irradiation induces mutagenic effect, whereas lower levels cause stimulatory effect. Gamma radiations have been successfully exploited by Kumari (1995) in *Vicia* and Rehman *et al.* (1992) in *Cucurbita moschata* for improving germination, growth parameters and sex expression. However, extensive studies have not been done in vegetable crops so far. Keeping these lacunae in view, it was considered worthwhile study the effect of gamma irradiation of seeds on the growth, sex expression and yield and to find out the correct dose of radiation for inducing mutations in bottle gourd (*Lagenaria siceraria* Standi.)

Materials and Methods

The freshly harvested seeds of bottle gourd variety Pusa Summer Prolific Long (PSPL) were obtained from National Seeds Corporation, New Delhi and irradiated with Cobalt-60 at Nuclear Research Laboratory, IART, New Delhi. The doses were 5, 0.75, 1.0, 1.25, 1.5, 1.75 and 2.0 k Rad. The untreated seeds served as control. The seeds were sown in well-prepared beds. The effect of gamma radiation of seeds on growth parameters (germination, length of vine and number of lateral branches), sex expression (node having the first staminate flower, node having the first pistillate flowers, number of staminate flowers and number of pistillate flowers), crop yield and fruit characters were recorded at appropriate stages. The recommended package of practices was applied. The investigation was carried out at the Horticulture Garden of C.S. Azad University of Agriculture and Technology, Kanpur during July to November in the year 2000. There were a total of 8 treatments with three replications and the experiment was laid out in randomized block design.

Results and Discussion

The observations clearly indicate that gamma radiation mutagenic treatments reduced germination percentage. Higher the dose of radiation, lower was the germination percentage. Similar results were also reported by Alsafadi and Simon (1996) and Khan and Siraj-ud-din

(1996) in mung bean. Further, gamma irradiation was also found to adversely affect the root and shoot growth and increasing doses of gamma irradiation (0, 0.4 and 0.6 KGY) progressively reduced the vigour of rice seedlings due to accumulation of growth inhibitors (Sur and Basu, 1993).

The number of lateral branches increased up to I Krad and decreased progressively with the higher doses. This can be attributed to harmful physiological effects brought about by higher doses of gamma rays, possibly resulting in the disruption of mitosis cycle and ultimately retardation of cell division. It is possible that the damage may have been caused at the tip of the growing meristematic region. These results are in agreement with the findings of Kaushik et al (1976) and Kaushik and Singh (1979). The length of main vine (682.80) and number of lateral branches (23.92) were highest with I Krad treatment. Therefore, as far as growth parameters are concerned, 1 k Rad dose increases the number of lateral branches as well as vine length and does not affect the germination significantly.

Gamma irradiation resulted in delayed appearance of staminate flowers. The increasing doses of gamma irradiation successively delayed the appearance of staminate flowers. On the contrary, earliness in appearance of female flowers was induced with increasing doses of gamma irradiation up to 1 k Rad; beyond which the number of nodes of appearance of first female flower went on increasing with increasing doses of gamma irradiation. The number of staminate flowers also decreased successively with increased irradiation doses. However, the number of pistillate flowers first increased up to 1 k Rad dose that was practically double (19.4) than that recorded under control (9.86) per vine. However, the number of pistillate flowers started decreasing successively with increasing dose beyond I Krad. These observations are in agreement with the results of Nath and Nladan (1986) in *Cucumis sativus*. This was due to gibberellins, which have been reported to induce male sex expression (Heslop-Harrison, 1972 and Iwahori *et al.*, 1970). On the other hand, gamma irradiation at lower doses has been reported to induce ethylene production (Maxie *et al.* 1966), which in turn has been reported to enhance female sex expression in plants (Iwahori, *et al.* 1970).

The yield components and vegetable yield were affected significantly by gamma irradiation. An increase in number, length, girth and weight of fruits was noted with the gamma irradiation treatment up to I Krad dose, beyond which yield along with all yield attributes started declining (Table 2). This might have taken place due to the low level of gamma irradiation, which alters the biochemical processes in which nucleic acid contents carbohydrate and increasing the vital activities (Sidorskii, 1966). Our results indicate that high level of radiations adversely affected vegetative growth and yield. It is likely that

Table 1. Effect of gamma irradiation on growth parameters and sex expression of bottle gourd var. PSPL

Dose of γ-irradiation (Krad)	Germination (%)	Number of lateral branches	Length of vine (cm)	Node having 1st staminate flower	Node having 1st pistillate flower	Number of staminate flowers	Number of pistillate flowers
0	83.00	9.00	510.00	21.19	39.08	252.6	9.86
0.50	81.00	10.50	548.34	23.40	32.88	215.42	12.67
0.75	79.55	12.41	566.58	25.48	31.60	210.48	14.62
1.00	75.35	23.92	682.80	28.25	29.56	193.30	19.40
1.25	74.11	22.83	651.91	28.97	30.20	190.70	17.67
1.50	73.00	21.16	622.71	30.81	32.16	185.53	15.13
1.75	69.67	18.66	599.96	31.93	38.74	181.28	13.43
2.00	66.00	16.33	576.00	34.93	41.08	167.48	10.88
C.D. (P=0.05)	8.20	1.33	53.83	1.78	3.46	22.60	0.15

Table 2. Effect of gamma irradiationon vegetable yield and fruit characters of bottle gourd var. PSPL

Dose of γ-irradiation (Krad)	Number fruits/plant	Lenght of fruits (cm)	Girth of fruits (cm)	Mean weight of individual fruit (Kg)
0	8.46	30.38	19.51	1.20
0.50	12.57	31.00	21.51	1.80
0.75	13.76	33.28	22.24	2.20
1.00	18.35	38.82	26.28	2.40
1.25	16.25	38.08	24.38	2.30
1.50	14.13	36.08	23.63	2.25
1.75	10.57	30.03	20.79	1.65
2.00	9.18	30.18	20.40	1.58
C.D. (P=0.05)	1.81	3.07	2.26	0.28

gamma irradiation exerts its effect on sex expression through an increase in ethylene evolution. Hence, it can be concluded that I Krad of gamma radiation is the most effective dose for inducing better growth, sex expression and yield of fruit in bottle gourd. The authors are gratefil to Nuclear Research Laboratory, IARI, New Delhi for gamma irradiation facilities and to Dr. G.S. Gaur, Professor and Head, Department of Horticulture, C. S. Azad University of Agriculture and. Technology, Kanpur for providing laboratory facilities.

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EFFECT OF STECKLING SIZE ON SEED YIELD AND QUALITY OF RADISH VAR. JAPANESE WHITE UNDER TEMPERATE CLIMATE

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Abstract

An investigation was carried out to study the effect of steckling size on vegetative growth, flowering date, seed yield, 1000-seed weight and germinability. It was observed that steckling of 1/3rd of the root size took the longest time to 50% flowering and 100% flowering and the whole root took the shortest time to 50% flowering and 100% flowering whereas the steckling of 2/3rds of root size showed intermediate effect for days to flowering. Whole root also resulted in highest yield as compared to root and 2/3rds root. Seed quality attributes *viz.*, 1000 seed weight and seed germination were also found to be affected significantly by the size of stecklings in both years In year 2001-02, the germination increased singnificantly in 2/3rds and full root over the control, however, the increase in germination was at par in latter treatments. In the 2nd year, the germination significantly increased with increase in steckling size. Larger steckling can be recommended for higher seed yields of radish under temperate climate.

Key words : Radish, seed production, seed quality, yield, steckling size.

Seed-to-seed and root-to-seed (transplanting) are the two methods that are practiced generally for seed production in radish. Transplanting method of seed production in radish was recommended by Singh *et al.* (1960). In transplanting method, steckling preparation and time of transplanting are two major components of radish seed production technology. It is common practice to transfer steckling around middle of November i.e., at the time when vegetative growth is compete and roots as well as shoots offer all the distinguishable characters for selecting the true to type roots. After transplanting the plants in winters, bolting takes place in March. The silique ripen till May-June and harvesting takes place till mid- July. The maximum temperature goes up to 18-20°C in March and to 22-24°C in April (Table 2). Due to rise in temperature of these months, low seed yield is harvested. Therefore, fast vegetative growth, early bolting and flowering are desirable. Keeping this in view, an experiment was undertaken to quantify the effect of steckling size on earliness in bolting, seed yield and seed quality.

Materials and Methods

The experiment was conducted at IARI and Nagger farm of Regional Station at Katrain (HP) at an elevation of 1688m above mean sea level. Radish var. Japanese White was subjected to three treatments viz., steckling size of 1/3rd of root, 2/3rds root and full root (approx. 27-30 cm). In the first year the transplanting was done on 6th December 2001 and in the second year on 2/3 November 2002. Stecklings of 1/3rd of root and 2/3rds of root were prepared with the help of a sterilized sharp knife leaving 1/3rd of roots (approx. 9cm) and 2/3rds of roots (approx. 18cm). The cut surface of stecklings was treated with a fungicide Cuman-L (Ziram 27 SC) for 30 minutes by dipping the stecklings in solution to prevent infection through the cut surface and control root rot. The shoot was shortened by cutting with a sharp knife leaving only 7-8m cm of shoot. Transplanting of stecklings was done the same day at 45x45 cm in flat bed, consisting of 36 plants in each replication. The experiment was conducted in 3 replications and was laid out in randomized block design and data were recorded on plant height, days to 50% flowering and days to 100% flowering. After harvest the seeds were dried to moisture content of nearly 8% seed yield per plant (g) and 1000 seed weight from different treatments combination were recorded. The germination of seeds harvested was tested using the recommended procedure (ISTA, 1999). All data were statistically analyzed as per Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

All the treatments produced significant effects on recorded parameters consistently in both the years. Radish steckling of the size of 1/3rd root took the longest time to 50% flowering and 100% flowering whereas whole root took the shortest time to 50% flowering and 100% flowering in 2001-02 as well as in 2002-03. The steckling of 2/3^{rds} of root was of intermediate effect for days to flowering in both the years. Whole root also resulted in highest yield (50.3g/plant and 41.9g/plant in 2001-02 and 2002-03 respectively) as compared to 1/3rd root (38.5 and 36.1 g/plant) as well as 2/3^{rds} root (42.7and 40.3 g/plant). The steckling size also affected the vegetative growth as indicated by the plant height, which was highest in case of complete root followed by 2/3^{rds} and 1/3rd of the root (Table 1). The trend was same in both the years. The earliness in flowering in full root and 2/3^{rds} of root size treatments can be attributed to rapid vegetative growth which in turn can be ascribed to unabated supply of nutrients stored on the stecklings till the adventitious root formation took place. The results were in keeping with an early report made from Punjab plains by Gill and Gill (1996). This gain in early vegetative growth resulted in profuse flower formation at the time when weather was conducive for pollination by bees as well as for seed maturation. Early completion of vegetative phase by one or two weeks is very important for temperate vegetable seeds where otherwise they used to mature late in summer after onset of monsoon. Arya and Saini (1978) found that stecklings of Carrot var. early Nantes weighing 40g gave higher seed yield in comparison to stecklings weighing 10, 20 and 30g. After a similar study on radish Gill and Gill (1996) had concluded that a very strong correlation of seed yield exists with steckling size over all dates of transplanting and whole root gave highest seed yield.

Seed quality attributes *viz.*, 1000 seed weight and seed germination were also found to be affected significantly by the size of stecklings in both years (Table 2). In year 2001-02 the germination increased singnificantly in 2/3 and full root over the control however the increase in germination was at par in latter treatments. In the 2 year the germination significantly increased with increase in steckling size. The advantage in terms of seed weight can be ascribed to the differential supply of nutrients by stecklings of different sizes in the initial stages of growth of flowering stalk.

Therefore, it can be easily concluded that earliness of flowering can be obtained by planting larger stecklings and loss of seed yield as a consequence of delayed planting on any account can be made up by increasing the size of stecklings instead of hormonal spays as suggested by (Joshi

Table 1. Effect of different steckling sizes on plant growth, time of flowering and seed yield of radish

Treatment	Days to 50% flowering		Days to 100% flowering		Plant height (cm)		Yield/plant (g)	
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
1/3rd root (control)	106.7	102.0	115.0	111.3	117.00	108	38.5	36.1
2/3^{rds} root	101.6	96.7	110.7	104.3	115	115	42.7	40.3
Full root	95.3	91.3	104.0	99.7	131.3	131.3	50.3	49.3
C.D. (P=0.05)	3.7	2.1	2.93	2.9	3.4	3.4	3.85	7.3

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Table 2. Effect of different steckling sizes on radish seed quality

Treatment	Test weight (g)		Germination	
	2001-02	2002-03	2001-02	2002-03
1/3rd root (control)	17.6	16.1	85.00	86.25
2/3rds root	19.5	20.6	89.25	90.00
Full root	22.7	24.0	90.75	94.25
C.D. (P=0.05)	1.52	1.88	4.01	3.65

and Singh, 1975 and Nautiyal and Lal, 1982). Since, the use full size stecklings doesn't offer the opportunity to reject on the basis of pithiness or black core, so it is suggested that this method should not be practiced for production of nucleus, breeder and foundation seed.

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EFFECT OF CROPPING SYSTEMS, MOISTURE CONSERVATION PRACTICES AND FERTILITY LEVELS ON GROWTH AND YIELD OF PIGEONPEA AND MUNGBEAN IN INTERCROPPING SYSTEM

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ABSTRACT

A field experiment on moisture conservation and nutrient management studies in pigeonpea + mungbean intercropping system under rainfed conditions was conducted during *kharif* seasons of 2004 and 2005. The treatment combinations comprised two cropping systems and three moisture conservation practices. The results indicated that planting of one row of mungbean in between paired rows (30/70 cm) of pigeopea was superior over sole pigeonpea in respect of pigeonpea equivalent yield. Application of dust mulch + FYM 5t/ha + 6% kaolin spray was the best misture conservation practice by recording higher growth and yield of pigeonpea and mungbean over rest of the treatments. Application of 40 kg P_2O_5/ha + 25 kg S/ha recorded markedly higher growth and yield of pigeonpea under both sole and intercropping system as well as mungbean as compared to control and 40 kg P_2O_5/ha and it was at par with 40 kg P_2O_5/ha + 25 kg S/ha + PSB.

Key words : Intercropping, fertility levels, mulch, pigeonpea, mungbean.

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is an important *kharif* grain legume in India grown predominantly uder rainfed conditions. It occupies about 27 per cent of total pulse area but accounts for only 17% of gross pulse production in the country. With the development of several short and medium duration compact plant varieties with higher productivity pigeonpea of late is becoming popular in several dryland tracts of India.

Pigeonpea has initial slow rate of growth up to 45-60 days, with a scope for a short duration crop like mungbean as intercrop.

Adequate soil moisure is the key to successful crop production in dry land areas. Use of organic manure as well as mid season corrections through mulches, antitranspirants and planting methods are effective in increasing productivity and water use by pigeon pea under rainfed conditions.

A good deal of research work has been done on nutrient management and moisture conservation practices. Yet, there exists a lacuna in assessing favourable effect of moisture conservation and nutrient management and their interaction in pigeonpea+mungbean intercropping system under rainfed conditions. Therefore, it was deemed desirable to investigate the role of intercropping systems coupled with moisture conservation practices and nutrient management in rainfed pigeonpea.

MATERIALS AND METHODS

A field experiment was conducted on a sandy loam soil at the research farm of the Division of Agronomy, Indian Agricultural Research Institute, New Delhi during *kharif* 2004 and 2005. This location has a typical semi-arid and sub-tropical climate characterized by hot dry summer and cool winter. The rainfall received during the growing period from July to December was 283 mm in 2004 and 677.5 mm in 2005. The experiment was laid out in split-plot design with three replications. The treatment combinations comprised two cropping systems viz. pigeonpea sole (50 cm row spacing) and pigeonpea paired row (30/70 cm row spacing) + one row of mungbean and three moisture conservation practices (dust mulch. dust mulch + FYM@ 5 t/ha and dust mulch + FYM @ 5 t/ha + kaolin 6% spray) in main plots and four fertility levels viz. control, 40 kg P_2O_5/ha, 40 kg P_2O_5/ha +25 kg S/ha and 40 kg P_2O_5/ha +25 kg S/ha + PSB in subplots.

Fertilizers were drilled in bands 8-10 cm below the surface. Full dose of phosphorus and sulphur as per treatments through SSP and gypsum, respectively were applied just before sowing of crops. FYM was incorporated in the polts after preparing layout as per treatments in both the years. Pusa -991 and Pusa Ratna varieties of pigeonpea and mungbean, respectively were used for experimental purpose. Sowing was done on 8th July in 2004 and 1st July in 2005. The pigeonpea seeds were sown @ 15 kg/ha by dropping the seeds in furrows behind the plough. The seed rate of mungbean was decided according to space available for intercropping in pigeonpea. The spacing between row to row in sole pigeonpea was maintained at 50 cm while, the paired row sowing was done at a distance of 30 cm apart and distance between two pairs of rows was 70 cm. One row of mungbea was sown in between two paired rows of pigeonpea.

The first dust mulch was created at 25 DAS and second was at 40 DAS in both the years. The kaolin (6 per cent suspension) was sprayed as per treatments over the crop foliage at 80 DAS in both the years. Plants from the net plot area were harvested from the ground level and were left for sun drying *in-situ*. Pigeonpea and mungbean were threshed manually. Grains were cleaned and weighted for expressing yield in q/ha. The weight of stalk was recorded separately and used for estimating stover yield.

RESULTS AND DISCUSSION

Pigeonpea

The cropping system failed to affect the plant height, LAI and dry matter production of pigeonpea at various stages of the crop growth (Table 1). This might be due to the absence of competition between pigeonpea and mungbean for nutrients, moisture, solar radiation because of shorter duration and non-spreading nature of mungbean. Moisture conservation practices showed marked improvement in plant height, LAI and dry matter production. Dust mulch + FYM @ 5 t /ha + kaolin and dust mulch + FYM @ 5 t/ha caused significant improvement in growth attributes at all the growth stages of crop over dust mulch. This could be attributed to an extended period of moisture availability, improved soil physical properties, hydraulic conductivity as well as availability of NPK due to FYM and mulching. Siminar results were also reported by Jat and Gautam (2000).

Application of 40 kg P_2O_5 + 25 kg S/ha + PSB significantly improved all the growth attributes at all the growh stages of crop over control and 40 kg P_2O_5/ha and was on par with 40 kg P_2O_5 + 25 lg S/ha. It could be ascribed to pivotal role of phosphorus and sulphur in several physiogical and biochemical processes. Cropping system had no effect on yield attributes *viz.*, pods/plant, grains/pod and 1000-grain weight and grain and stalk yield of pigeonpea. Yield attributes and yield of pigeonpea were influenced remarkably due to moisture conservation practices. Dust mulch + FYM @ 5 t/ha recorded the highest values in respect of yield attributing characters and yield. This could be assigned due to the combined effect of these components in more effectively reducing the evapotranspiration losses and increasing water holding capacity of soil.

Application of 40 kg P_2O_5/ha + 25 kg S/ha + PSB significantly improved all the yield attributes and yield of pigeonpea over control and 40 kg P_2O_5/ha. The improvement, in yield components might have resulted from favourable influence of phosphorus and sulphur nutrition on the growth parameters leading to greater nutrient uptake, efficient partitioning of metabolites, adequate translocation and accumulation of photosynthates, aminoacids, vitamins *etc.* The observations of the present study are in line with the findings of shivran *et al.* (2000) and Jat and Ahlawat (2003).

Mungbean

Maximum values of growth attributing characters were recorded under dust mulch + FYM @ 5 t/ha + kaolin 6% spray. This might be due to reduction in evapotranspiration losses of water, suppression of weeds and conservation of soil moisture, which ultimately led to extended period of water availability.

Table 1. Effect of cropping systems, moisture conservation practices and fertility levels on growth parameters at harvest, yield attributes and yield of pigeonpea (Mean of 2 years)

Teatment	Plant height (cm)	Dry matter accum-ulation (g/plant)	No. of pods/plant	No. of grains/ pod	1000-grain weight (g)	Grain yield (q/ha)	Stalk yield (q/ha)	Pigeonpea equivalent yield(q/ha)
Cropping system								
Pigeonpea sole (50 cm)	148.08	70.13	164.58	3.60	74.68	16.28	54.41	16.28
Pigeonpea paired sow (30/70 cm) + one row of mungbean	150.76	67.60	158.40	3.53	73.66	15.78	52.15	18.25
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	0.80
Moisture conservation practices								
Dust mulch	143.04	65.58	154.16	3.39	72.50	14.96	50.27	16.00
Dust mulch + FYM 5t/ha	151.54	69.34	164.06	3.62	74.81	16.40	54.17	17.69
Dust mulch + FYM 5t/ha+Kaolin 6%	153.69	71.68	166.26	3.68	75.19	16.74	55.40	18.09
CD (P=0.05)	7.42	3.83	7.92	0.20	NS	1.01	3.29	1.00
Fertility levels								
Control	133.40	60.60	144.30	3.00	70.57	13.34	44.99	14.22
P_2O_5 40 kg/ha	146.95	67.62	158.29	3.50	73.51	15.44	51.00	16.59
P_2O_5 40 kg/ha + 25 kg S//ha	158.21	73.19	170.11	3.83	75.79	17.34	57.50	18.74
P_2O_5 40 kg/ha + 25 kg S/ha + PSB	159.14	74.07	173.25	3.93	76.81	18.00	59.66	19.51
CD (P=0.05)	9.49	4.79	11.03	0.24	NS	1.16	4.04	1.17

Table 2. Effect of moisture conservation practiees and fertility levels on growth parameters at harvest, yield parameters and yield of mungbean in pigeonpea+mungbean intercropping system (Mean of 2 years)

Teatment	Plant height (cm)	Dry matter accum-ulation (g/plant)	No. of pods/plant	No. of grains/ pod	1000-grain weight (g)	Grain yield (q/ha)	Stover yield (q/ha)
Moisture conservation practices							
Dust mulch	43.38	8.84	17.22	5.05	45.38	2.10	10.25
Dust mulch + FYM 5t/ha	48.89	10.14	19.58	5.77	45.99	2.56	12.18
Dust mulch + FYM 5t/ha+kaolin 6%	-	10.30	19.95	5.84	46.07	2.71	13.07
CD (P=0.05)	4.90	1.04	1.81	0.61	NS	0.31	1.33
Fertility levels							
Control	41.84	8.14	15.98	4.78	95.21	1.75	8.55
40 kgP_2O_5 /ha	46.44	9.82	18.41	5.40	95.74	2.29	11.06
P_2O_5 40 kg/ha + 25 kg S/ha	51.27	10.61	20.47	5.98	46.05	2.77	13.35
40 kg P_2O_5 /ha + 25 kg S/ha + PSB	42.02	10.87	20.79	6.06	46.26	3.00	14.36
CD (P=0.05)	4.29	0.94	1.71	0.50	NS	0.33	1.32

Application of 10 kg P_2O_5 /ha + 25 kg S/ha + PSB significantly improved the growth attributes of mungbean over control, 40 kg P_2O_5/ha. This might be due to favorable effect of phosphorus and sulphur on root development, nodulation, photosynthesis, protein synthesis and energy transfer process during crop season.

Moisture conservation practices produced significant improvement in yield attributing characters viz., pods/plant, grains/pod and 100-grain weigh and stalk yields of mungbean but failed to produce marked influence on harvest index. This might be due to vigorous crop growth resulting from increased availability of soil moisture due to different moisture conservation practices.

Application of fertility levels enhanced the yield attributes viz. pods/plant, grains/pod and grain and stover yields of mungbean (Table 2). It was observed that the application of 40 kg P_2O_5/ha+25 kg S/ha +PSB significantly improved all the yield attributes and yield of mungbean over control and 40 kg P_2O_5/ha. This might be due to favourable influence of phosphorus on growth characters, nodulation and translocation of photosynthates.

Pigeonpea equivalent yield

Pigeonpea intercropped with mungbean recorded significantly higher pigeonpea equivalent yield as compared to sole pigeonpea (Table 1). The higher pigeonpea equivalent yield in intercropping treatment was due to similar yield of pigeonpea to that of its sole stand, and an additional yield of mungbean as a bonus in intercropping system. The results are in accordance with the findings of Jat (2002).

Dust mulch + FYM @ 5 t/ha t kaoline 6% spray being at par with dust mulch+FYM @ 5 t/ha recorded maximum pigeonpea equivalent yield. pigeonpea equivalent yield. It might be due to the fact that significant increase in grain yield of pigeonpea coupled with increased yield of mungbean in aforesaid treatments over dust mulch resulted in higher pigeonpea equivalent yield.

Application of 40 kg P_2O_5 + 25 kg S/ha + PSB recorded significantly higher pigeonpea equivalent yield over control and 40 kg P_2O_5/ha. This might be attcributed to increase in economic yield of both the component crops with phosphorus and sulphur application. The contributing effect of various yield attributes and yield fetched the maximum pieonpea equivalent yield with fertility levels. Similar results were also reported by Jat (2002) and Kantwa (2004).

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EFFECT OF FYM, CROPPING SYSTEM, SOURCES AND LEVELS OF SULPHUR ON GROWTH ATTRIBUTES, YIELD AND PIGEONPEA EQUIVALENT YIELD IN PIGEONPEA + GROUNDNUT INTERCROPPING SYSTEM

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) seasons of 2003 and 2004 at IARI, New Delhi to study the response of pigeonpea + groundnut intercropping system to sources and levels of sulphur along with the FYM. Application of FYM increased the growth attributes and yield of both pigeonpea and groundnut and pigeonpea equivalent. However, intercropping did not have any impact of these parameters, except pigeonpea equivalent yield. Application of sulphur @ 35 and 70 kg S/ha, being on par, significantly improved the growth attributes, yield attributes and yield of both pigeonpea and groundnut and pigeonpea equivalent. Among the sources, cosavet recorded higher growth attributes and yield of pigeonpea and groundnut and pigeonpea equivalent yield over elemental sulphur and gypsum.

Key words : FYM, intercropping, sulphur, pigeonpea equivalent yield.

Grain legumes occupy an important place in human's food and nutritional requirements. They contain the same amount of calories as that of cereals, but protein content is twice that of cereals. They also supply vitamins, minerals and fat. Intercropping of pigeonpea with groundnut is a common practice in many states. In pigeonpea, a lot of inter-row space remains vacant during the early growth stages and get infested by weeds. Groundnut as an efficient cover crop fits well n this system as it exhibits vigorous early growth and comes to flowering by the time pigeonpea enters grand growth period. Sulphur plays an important role in the formation of S containing amino acids (methionine, cysteine and cystine), synthesis of proteins, promotion of nodulation and production of bolder grains in grain legumes. The information on the effect of sources and levels of sulphur is meager, especially in a popular intercropping system like pigeonpea + groundnut. Keeping in view these points the present investigation was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during the rainy (*kharif*) seasons of 2003 and 2004 at IARI, New Delhi. The treatments consistsed of combinations of 0 and 5 t FYM/ha, sole pigeonpea and pigeonpea +groundnut intercropping in the main plots and 9 treatments in sub plots viz., 0 kg S/ha, elemental S @ 35 kg/ha, 35 kg S/ha in the form of gypsum, 70 kg S/ha in the form of gypsum, 35 kg S/ha and in the form of cosavet and 70 kg S/ha in the form of cosavet. The soil of the experimental field was slightly alkaline in reaction (pH 8.1), low in organic carbon (0.37%) and available P (8.30 kg/ha) and medium in available K (176.0 kg/ha). Pigeonpea variety Pusa 855 was grown in additive series of intercropping with groundnut variety M-522, using a seed rate of 15 and 100 kg/ha, respectively. Crops were uniformly fertilized with recommended dose of N and P_2O_5, applied before sowing of crops.

RESULTS AND DISCUSSION

Growth attributes

Growth attributes viz., height, no. of branches/plant and LAI of both pigeonpea and groundnut were significantly improved due to application of FYM @ 5 t/ha over no FYM at all the growth stages. This led to increased dry

Table 1. Effect of FYM, cropping system, sources and levels of sulphur on growth attributes, yield of pigeonpea and pigeonpea equivalent yield

Treatment	Plant height (cm)		No. of Branches /Plant		LAI		Dy matter (g/Plant)		Grain yield (q/ha)		PEY* (q/ha)	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
FYM (t/ha)												
0	152.80	148.68	16.2	15.9	2.04	1.91	76.40	70.80	14.60	13.77	15.19	14.05
5	159.08	154.97	16.8	15.5	2.08	1.95	80.54	74.93	5.47	14.75	17.40	16.65
CD at 5%	3.17	2.81	0.33	0.21	0.03	0.03	1.40	1.67	0.73	0.22	.35	0.30
Cropping system												
Sole pigeonpea	157.12	153.01	16.5	16.2	2.06	1.93	78.97	73.37	15.09	14.35	15.09	14.35
Pigeonpea +groundnut intercropping system	154.76	150.64	16.4	16.1	0.01	1.93	77.96	72.36	14.99	14.17	17.58	16.36
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Source and levels of S (kg/ha)												
Control	146.42	139.77	15.4	15.0	1.95	1.83	69.54	63.94	13.34	12.37	15.01	13.93
Elemental S @ 35 kg/ha	154.50	149.60	16.2	16.0	2.03	1.91	77.54	71.94	14.44	13.25	16.38	15.39
Elemental S @ 70 kg/ha	156.53	151.63	16.5	16.0	2.05	1.92	79.51	73.99	14.64	13.52	17.24	15.93
Gypsum @ 35 kg/ha	155.43	150.53	16.3	16.1	2.08	1.93	78.38	72.78	14.61	13.82	16.65	15.71
Gypsum @70 kg/ha	157.53	151.63	16.6	16.2	2.09	1.94	80.48	74.88	14.85	14.17	18.11	16.44
Cosavet @ 35 kg/ha	160.50	159.77	17.1	16.9	2.12	2.00	81.62	75.92	16.62	16.02	19.57	17.68
Cosavet @ 70 kg/ha	160.67	159.85	17.1	16.9	2.12	2.00	82.13	76.63	16.79	16.48	19.86	18.07
CD at 5%	8.33	8.83	0.76	0.90	0.08	0.08	4.06	3.96	0.91	0.86	0.76	0.80

* Pigempea equivaliml yield

Table 2. Effect of FYM, sources and levels of sulphur on growth attributes and yield of groundnut

Treatment	Plant height (cm)		No. of branches /Plant		LAI		Dy matter (g/Plant)		Pod yield (q/ha)	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
FYM (t/ha)										
0	34.89	34.71	6.83	6.59	2.11	2.06	26.22	27.85	4.31	3.97
5	38.49	38.31	7.44	7.17	2.20	2.10	28.25	28.84	5.40	5.05
CD at 5%	0.92	1.26	.23	0.20	0.07	0.07	0.68	.81	0.06	0.06
Source and levels of S (kg/ha)										
Control	32.12	31.94	5.91	5.67	1.90	1.84	21.14	23.76	3.66	3.29
Elemental S @ 35 kg/ha	35.09	34.91	7.03	6.79	2.12	2.04	26.46	26.18	4.68	4.30
Elemental S @ 70 kg/ha	37.02	36.84	7.05	6.81	2.13	2.10	27.23	26.77	4.70	4.38
Gypsum @ 35 kg/ha	36.05	35.87	7.04	6.80	2.13	2.05	26.51	26.23	4.69	4.32
Gypsum @70 kg/ha	37.17	36.99	7.06	6.82	2.14	2.11	27.27	26.79	4.71	4.39
Cosavet @ 35 kg/ha	39.26	39.08	7.94	7.69	2.33	2.25	29.51	29.07	5.81	5.40
Cosavet @ 70 kg/ha	40.16	39.98	7.96	7.70	2.34	2.30	29.53	29.13	5.83	5.52
CD at 5%	2.40	2.72	0.57	0.54	0.18	0.14	2.17	2.23	0.31	0.35

matter accumulation per plant in both the crops. Most of the Indian soils are poor in organic matter which besides being source of several macro and micronutrients favourably affects physical, chemical and biological properties of soil for plant growth. Application of FYM increased the supply of easily assimilated major as well as micronutrients to plants, besides mobilizing unavailable nutrients into available from. However, intercropping of pigeonpea with groundnut did not significantly affect growth attributes at all the growth stages. This may be due to non-competitive environment between main crop and the intercrop in respect of growth resources such as moisture, solar radiation and nutrients owing to different growth habits of pigeonpea and groundnut. Similar findings have also been reported by Giri (1990). Application of sulphur @ 35 and 70 kg S/ha across the sources, being on par, significantly increased the growth attributes viz., plant height, branches/ plant, LAI and dry matter accumulation/plant over to sulphur in both the years. The overall improvement in growth with addition of sulphur in both the years. The overall improvement in growth addition of sulphur could be ascribed to its pivotal role in several physiological and biochemical processes which are of vital importance for development of the plants. Besides, sulphur is also involved in the formation of amino acids viz., cysteine, methionine, synthesis of proteins, vitamins and chlorophyll. Among the sources of sulphur, cosavet recorded marked improvement in growth attributes as compared to elemental S and gypsum. This increase in growth attributes due to cosavet may be attributed to the fact that cosavet has smaller particle size and thereby increases the surface area hastening the oxidation of sulphur to sulphate, which is the available form of sulphur to plants. This property of cosavet might have increased the availability of sulphate to plants in early growth phase when it is required for proper root growth and nodulation. Similar results have also been reported by Arora *et al.* (1991).

Yield

The increase in grain yield of pigeonpea due to application of FYM @ 5 t/ha was 5.9 and 7.1% in 2003 and 2004, respectively. The corresponding increase in groundnut pod yield was 25.0 and 27.3%, respectively. Similar results were also reported by Chaithanya Devi *et al.* (2003). Intercropping had no effect on yield of pigeonpea. It is thus obvious that the conditions for growth and development of pigeonpea in intercropping and solid stand were identical since groundnut crop having different growth haqbit (canopy, height, growth duration, etc.) could not pose any competition to pigeonpea. Gupta and Rai (1999) also reported similar findings in pigeonpea + groundnut intercropping system. Results showed that application of 35 kg S/ha significantly increased the yield of both pegeonpea and groundnut. The yield increment due to application of 35 and 70 kg S/ha over the sources was 14.11 and 15.64 % in 2003 and 16.11 and 19.02% in 2004, respectively as compared to no sulphur. The corresponding values in groundnut were 38.25 and 38.79% in 2003 and 41.94 and 44.68% in 2004, respectively. Improvement in yield might have resulted from favourably influence of S on the growth characters viz., plant height, branching , LAI and dry matter accumulation and efficient and greater partitioning of metabolites and adequate translocation of nutrients of nutrients to developing reproductive structures. The results of the present study are in line with the findings of Singh and Ali (1994). The increase in grain and pod yield of pigeonpea and groundnut, respectively by application of S was largely a function of improved growth and consequent increase in yield attributing characters.

Among the sources of sulphur, cosavet markedly improved the growth attributes and yield of pigeonpea and groundnut. This was a result of improved plant growth and development of yield parameters due to cosavet over elemental S and gypsum. Similar results were also recorded by Palsaniya (2005) in pigeonpea.

Pigeonpea equivalent yield

Application of FYM had marked influence of pigeonpea equivalent yield over no FYM. This could be attributed to the fact that FYM significantly increased the yield of pigeonpea and groundnut, which finally led to significant increase in pigeonpea equivalent yield. Intercropping of pigeonpea with groundnut recorded significantly higher pigeonpea equivalent yield over sole pigeonpea. This was due to similar yield of pigeonpea to that of its sole stand, and an extra yield of groundnut as a bonus in intercropping system. Placation of sulphur markedly enhanced the pigeonpea equivalent yield over no sulphur. This might be attributed to increase in economic yield of both the component crops with S application. Similar result was also reported by Mehta *et al.* (1996). Among the sources, cosavet recorded markedly higher pigeonpea equivalent yield over elemental S and gypsum. This was due to the fact cosavet significantly improved the yield of both pigeonpea and groundnut as compared to elemental S and gypsum.

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DEVELOPMENT OF TEMPERATURE-BASED MODEL FOR PREDICTING PHENOLOGY OF RICE (*ORYZA SATIVA*) IN CENTRAL AGRO-CLIMATIC ZONE OF PUNJAB

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ABSTRACT

Field experiments were conducted during four consecutive *kharif* seasons of 1999-2002 at Ludhiana (Punjab) to evaluate the effect of temperature on phenological development of rice crop sown on two dates (D_1-2nd week of May and D_2-4th week of May). Rice cv. PR-114 attained physiological maturity in 128 to 138 days for first date of sowing and 135 to 143 days for second date of sowing. The growing degree days required from nursery sowing to physiological maturity ranged from 264_ to 2894 °C days for first date of sowing and 2736 to 2814°C days for second date of sowing with a coefficient of variation of 2.75%. A linear regression model was derived based on phenophasic data on temperature for predicting the onset of a particular phenophase of the crop.

Key words : Rice, *Oryza sativa*, phenophases, thermal time, temperature.

Rice is grown in Punjab during the *kharif* season under irrigated conditions. (Anonymous, 2004) Knowledge about occurrence of various phenologic events during crop growing season is an essential component of the crop-weather models. These models can be used to specify the most appropriate rate and time of specific plant growth and development process. In recent years, increasing interest has become evident for predicting crop development under field conditions (Angus *et al.* 1980). Temperature, light and moisture are the prime weather variables which affect plant life. However, regardless of how favourable moisture and light may be, the plant growth ceases when temperature drops below a critical minimum or exceeds a certain maximum value. The concept of growing degree days or heat units depicting the accumulated difference between mean temperature and base temperature has been used for characterizing phenological development and to predict maturity dates in crops (Nuttonson, 1955 ; Shanker *et al.* 1996). This concept was applied to predict phenology of wheat (Hundal *et al.* 1997) and mustard (Prabhjyot Kaur *et al.* 2005) using thermal based indices at Ludhiana. The present study was conducted to develop a thermo-based phenophasic model for the rice.

MATERIALS AND METHODS

The field experiments were conducted during four consecutive *kharif* seasons of 1999, 2000, 2001 and 2002 at Punjab Agricultural University, Ludhiana (30° 54' N, 75° 48'E, 247 m a.m.s.l.). This area is representative of the central irrigated plains of the state and is characterized by sub-tropical, semi arid climate. The average maximum and minimum temperature and rainfall during *kharif* season are 34.9°C, 22.8°C and 638 mm, respectively at Ludhiana (Hundal and Prabhjyot-Kaur, 2002). The experiment was laid out with two dates of nursery sowing (D_1-2nd week of May and D_2-4th week May) using rice variety PR-114. The rice seedlings were transplanted after 30 days using row to row and plant to plant spacing of 20 and 15 cm, respectively. The soil of the experimental field was loamy-sand. Te crop was raised as per recommended package of practices. Rice nursery beds were fertilized @ 65 kg/ha urea, 150 kg/ha single super phosphate and 100 kg/ha of zinc sulphate. Rice seed was treated with streptocycline @ 1 g/kg of seed. At the time of puddling operations, the field was fertilized with first dose of urea (92 kg/ha), single super phosphate (185 kg/ha), zinc sulphate (62 kg/ha). Nitrogen was applied in three equal split doses i.e., first at puddling, second at 21 days after transplanting and third at 42 days after transplanting. Weeds were removed by hand weeding and by spraying herbicide (Machete) @ 1200 ml/acre. Water was kept standing in the crop continuously for two weeks after transplanting. Afterwards, irrigation was applied 2-3 days after the ponded water disappeared. Heat units or growing degree days (GDD) were computed by taking a base temperature of 10 °C. The accumulated sum of growing degree days for each phenophase was obtained as follows :

$$\text{Accumulated GDD} = \sum_{ds}^{dh} \frac{[(T_{max} + T_{min})] - T_t}{2}$$

Where,

T_{max} = Daily maximum temperature (°C)
T_{min} = Daily minimum temperature (°C)
T_t = Base temperature (°C)
d_s = Date of sowing or starting date of the phenophase of interest
d_h = Date of harvesting or the phenophase of interest

One meter row length in each plot was selected randomly for regular indentification of the phenological events. Phenological events of P_1 (nursery raising), P_2 (transplanting to start tillering), P_3 (tillering to booting), P_4 (booting to headling), P_5 (heading to start grain filling), P_6 (start grain filling to physiolological maturity) and P_7 (sowing to physiological maturity) were considered. Whenever at least 50% plants from selected row in the plot attained a particular stage, the date was considered as the one for attainment of the stage. Growing degree days were accumulated from the date of sowing to each date of onset of phenological event to given accumulated GDD. A linear regression phenophasic model was derived based on the phenophase-wise temperature data pooled over two dates of sowing and four crop seasons for predicting the onset of any phenophse.

RESULTS AND DISCUSSION

Crop phenology

The number of days taken by the crop for completion of each phenophase varied with the date of sowing. The heading stage initiation ranged from 94 to 107 days for first date of sowing (D_1-2nd week of May) and 101 to 110 days for second date of sowing (D_2-4th week of May) in different crop years. The crop maturity ranged from 128 to 138 days for first date of sowing (D_1-2nd week of May) and 135 to 143 days for second date of sowing (D_2-4th week of May). The numbers of days taken to maturity under D_1 sowing were highest for the crop during *kharif* 2002 while under D_2, it was highest during *kharif* 2001. On an average, the rice cv. PR 114 attained physiological maturity in 136 days with a standard deviation of 4 days and revealed coefficient of variation (C.V.) of 3.2%.

Thermal time and crop phenology

Thermal time or heat units are widely used for describing the temperature response to growth and development of crops. Thermal time or GDD requirement for completion of different phenophases of rice are presented in Table 1. A decreasing trend in accumulated GDD was also observed with delayed sowing. The thermal units accumulated upto heading ranged from 2042 to 2303 °C days under D_1 (2nd week of May) and 2159 to 2286 °C days under D_2 (4th week of May) in different crop years. The thermal units accumulated upto physiological maturity ranged from 2644 to 2894 °C days under D_1 and 2736 to 2814 °C days under D_2 in different crop years. Rice cv. PR-114 on an average accrued thermal units of 2775 °C days for attaining physiological maturity with a standard deviation of 76.4 °C days and a coefficient of variation (C.V.) of 2.75%.

Thermo-based phenophasic model

A liner regression model was derived based on the phenophase-wise temperature data pooled over two dates of sowing and four crop years given below for predicting the onset of any particular phenophase in rice cv. PR-114 :

$$Y = 0.0489^{*}\,\text{AGDD} + 0.1921 \quad (R^2 = 0.09)$$

Where, Y = Predicted number of days
AGDD = Accumulated GDD or themal units (°C days) for that particular phenophase

Table 1. Accumulated heat units (°C days) for different phenoloical stage of rice (cv. PR-114) under two dates of sowing for four consecutive crop seasons (*kharif* 1999-2002)

Phenological period	D_1 (2nd week of May)				D_2 (4th week of May)				Mean (°C days)	SD (°C days)	CV (%)
	1999	2000	2001	2002	1999	2000	2001	2002			
P_1 : Nursery sowing to transplanting	655.0	698.2	659.2	680.6	673.2	676.3	635.8	680.8	669.9	19.2	2.9
P_2 : Transplanting to start tillering	199.0	206.7	182.0	129.2	194.2	240.3	199.7	179.9	191.4	31.3	16.3
P_3 : Tillering to booting	1119.5	1174.7	923.5	1056.8	1172.2	1183.6	1066.3	1171.5	1108.5	90.1	8.1
P_4 : Booting to heading	243.8	223.9	277.5	249.7	171.3	186	257.8	237.8	231.0	36.0	15.6
P_5 : Heading to start grain filling	156.5	191.9	203..5	391.7	235.45	150.8	180.2	143.6	206.7	80.7	39.0
P_6 : Start grain filling to physiological maturity	270.1	335.1	474.9	386.0	289.4	329.0	454.8	400.8	367.5	74.3	20.2
P_7 : Sowing to Physiological maturity	2644.1	2830.1	2720.7	2894.0	2736.05	2766.1	2794.8	2814.5	2775.1	76.4	2.75

The model indicated that GDD accounted for 99 per cent variation in the onset of different phenophases. By using this model, the dates required for various phenophases to occur can be predicted by using minimum values of GDD required to reach that particular phenophase. The model was validated and the actual and model-predicted days for each phenophase are compared in Table 2. The deviations were highest in P_3 (tillering to booting) in crop year 2002 under D_1 and in P_7 (sowing to physiological maturity) in crop year 2001 under D_2. The coefficient of variation for P_2, P_3, P_4, P_5 and P_6 stage under field conditions was 16, 10, 14, 36 and 22%, respectively.

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Table 2. Comparison of actual and predicted days required to attain various phenophases of rice (cv. PR-114) for two dates of sowing

Phenological period		D_1 (2nd week of May)				D_2 (4th week of May)				Mean	SD	CV (%)
		1999	2000	2001	2002	1999	2000	2001	2002			
P_1 : Nursery sowing to transplanting	Actual	30	30	30	30	30	30	30	30	30.0	0.0	0.0
	Predicted	32	34	32	33	33	33	31	33	32.6	0.92	2.8
	Deviation	+2	+4	+2	+3	+3	+3	+1	+3	+3		
P_2 : Transplanting to start tillering	Actual	9	9	9	6	9	11	10	8	8.9	1.5	16.4
	Predicted	10	10	9	7	10	12	10	9	9.6	1.4	14.6
	Deviation	+1	+1	0	+1	+1	+1	0	+1	+1		
P_3 : Tillering to booting	Actual	55	58	46	47	59	60	53	54	54.0	5.2	9.7
	Predicted	55	58	45	52	57	58	52	57	54.2	4.5	8.2
	Deviation	0	0	-1	+5	-2	-2	-1	+3	0		
P_4 : Booting to heading	Actual	12	11	14	12	9	10	13	13	11.7	1.7	14.2
	Predicted	12	11	14	12	8	9	13	12	11.4	2.0	17.5
	Deviation	0	0	0	0	-1	-1	0	-1	0		
P_5 : Heading to start grain filling	Actual	8	10	10	20	12	8	10	9	10.9	3.9	35.9
	Predicted	8	10	10	19	12	8	9	7	10.4	3.8	36.8
	Deviation	0	0	0	-1	0	0	-1	-2	0		
P_6 : Start grain filling to physiological maturity	Actual	14	18	25	23	16	19	27	24	20.75	4.6	22.4
	Predicted	13	17	23	19	14	16	22	20	18	3.6	20.1
	Deviation	0	-1	-2	-4	-2	-3	-5	-4	-1		
P_7 : Sowing to physiological maturity	Actual	128	136	134	138	135	138	143	138	136.2	4.3	3.2
	Predicted	129	139	133	142	134	135	137	138	135.9	4.0	3.0
	Deviation	+1	+3	-1	+4	-1	-3	-6	0	0		

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EFFECT OF *VIGNA RADIATA* SEED COAT FUNGI ON *IN VITRO* PHOSPHATE SOLUBILIZATION BY PHOSPHOBACTERIA

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ABSTRACT

Aspergillus spp., *Cephalosporium* spp., *Penicillium* spp. and *Trichoderma* spp. were isolated from the spermosphere of *Vigna radiata* varieties. Effect of these fungi on commonly used phosphobioinoculant bacteria was assayed *in vitro* using tricalcium phosphate and Mussorie rock phosphate. *Cephalosporium* spp. and *Penicillium* spp. inhibited the phosphate solubilizing capacity of these phosphobacteria. However, *Aspergillus* spp. significantly improved the phosphate solubilizing ability of the tested phosphobacteria. Microflora on the seed surface play an important role in determining the performance of phosphobacteria. The negative effect of *Cephalosporium* spp. and *Pencillium* spp. was attributed to a heat labile fungal metabolite. This may be an antibiotic like substance.

Key words : Spermosphere, *Vigna radiata, Pseudomonas striata, Bacillus polymxa,* fungi.

A large fraction of inorganic phosphates applied to soil as fertilizers is rapidly immobilized after application and becomes unavailable to the plants (Yadav and Dadarwal, 1997). Several bacteria and fungi have been reported to solubilize phosphorus from insoluble sources such as rock phosphate and other insoluble forms of phosphorus in the soil. These organisms play an important role in rendering insoluble soil phosphates available to crop plants and augment crop yields (Asea *et al.,* 1998). Seed or seedling bacterization with phosphobacteria improves the availability of phosphorus and hence the yield of crop plant. Coating the seed surface with carrier based phosphobacteria is one of the commonly used method. The seed surface (Spermosphere) harbors its own microflora. The present investigation was undertaken to evaluate the behaviour of commonly used PSB in the presence of *Vigna radiata* spermosphere microflora. The study is confined only to the fungi isolated from the seed surface of *Vigna radiata* varieties.

MATERIALS AND METHODS

An experiment was conducted under laboratory conditions during 2001-2002 to assess the influence of seed surface microflora of *Vigna radiata* on the performance of phosphobacterial inoculants. The experimental material namely phosphate solubilizing bacteria (PSB) *Pseudomonas striata* (P_{27}) and *Bacillus polymxa* (H_5) were obtained from the Division of Microbiology, Indian Agricultural Research Institute (IARI), New Delhi. Pikovskaya's medium (Pikovskaya, 1948) was used for maintenance of PSB. Seeds of genetically distinct varieties of mungbean (*Vigna radiata* spp.) namely, Pusa Vishal, Pusa 9072, Pusa Ratna, Pusa 9531, Baisakhi, Pusa 105 and PS 16 were obtained from the Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi. The seeds of these varieties were used for the isolation of spermosphere fungi.

In order to isolate the seed surface microflora the seeds were thoroughly washed with sterilized distilled water under aseptic condition. Aliquot of the wash water was plated on potato dextrose agar (PDA) medium. After screening and purification the fungal growth on the PDA medium was taxonomically identified as *Cephalosporium* spp. *Trichoderma* spp. *Aspergillus* spp. and *Penicillium* spp. These fungi were individually screened for their phosphate solubilization ability by culturing on a defined medium, NBRIP (Nautiyal, 1999). Tricalcium phosphate (TCP) @ 5 g/l and Mussoori rock phosphate (MRP) (19.0% P_2O_5) were added as inert phosphorus source. *P. striata* (P_{27}) and *Bacillus polymxa* (H_5) were also tested on defined growth medium (NBRIP) using TCP and MRP added @ 1 mg/ml as inert 'P' source. The flasks with medium were sterilized at 15 lb pressure for 20 minutes. After sterilization the flasks were inoculated with 0.5 ml of mycelium and spore suspension of individual fungi into the 48 hr old culture of PSB (32.7 x 10^8 cfu/ml). The extent to which the fungus affected the phosphate solubilising ability of these phosphobacteria (PS_{27} and H_5) was determined by allowing the bacteria to interact individually with all the four fungi in NBRIP broth supplemented with TCP or MRP added @ 1 mg P_2O_5/ml. The estimation of phosphate solubilized was carried out after 14 days of incubation by chloromolybdo blue colour method at 660 nm using UV-visible spectrophotometer.

Halo zone studies were performed by fortifying the NBRIP solid agar medium with culture filterates (10%) of individual fungi, and the mixture was poured in sterilized petri plates. The two bacterial cultures (P_{27} & H_5) were stabbed in triplicate using sterile tooth picks. The halo and colony diameters were measured after 14 days of incubation of plates at 30 ± 2° C. The halo size was calculated by substracting the colony diameter from the total diameter.

RESULTS AND DISCUSSION

The results (Table 1) showed that the fungi isolated from the spermosphere of different varieties of *Vigna radiata* were individually able to release a significant amount of orthophosphate from inert sources of phosphorus namely, tricalcium phosphate (TCP) and rock phosphate. The fungi *Aspergillus* spp. and *Penicillum* spp. were found to be better solubiliser of TCP or MRP than the bacterial cultures (P_{27} & H_5). However, a combination P_{27} or H_5 with *Cephalosporium* spp. and *Penicillium* spp. resulted in a significant decrease in the net release of

Table 1. *In vitro* phosphate solubilising capacity of fungi isolated from the surface of mungbean (*Vigna radiata*) seeds and their effect on phosphobacteria (average of six replicates)

Test organisms	TCP		MRP	
	mg P_2O_5/100 ml	mg P_2O_5 solubilized	mg P_2O_5/100 ml	mg P_2O_5 solubilized
Pseudomonas striata (P_{27})	48.00	44.16	16.27	15.37
Bacillus polymxa (H_5)	40.35	36.51	12.87	11.97
Cephalosporium spp.	28.36	24.52	8.32	7.42
Penicillium spp.	40.86	37.02	20.51	19.61
Aspergillus spp.	87.50	83.66	26.67	25.77
Trichoderma spp.	30.06	26.76	7.82	6.92
P_{27} + *Cephalosporium* spp.	22.3	18.46	7.46	6.56
P_{27} + *Penicillum* spp.	19.5	15.66	9.37	8.47
P_{27} + *Aspergillus* spp.	73.8	69.96	21.02	20.12
P_{27} + *Trichoderma* spp.	42.5	38.66	13.29	12.39
H_5 + *Cephalosporium* spp.	36.02	32.18	8.96	8.06
H_5 + *Pencillium* spp.	35.42	31.58	9.46	8.56
H_5 + *Aspergillus* spp.	74.2	70.36	23.2	22.3
H_5 + *Trichoderma* spp.	10.52	6.68	1.87	0.97
Control*	3.84	-	-	-

Incubation time 15 days, Incubation temperature 30 ± 2°C
*Uninoculated autoclaved medium, incubation time 15 days

Table 2. Effect of culture filterate of different spermosphere fungi on tricalcium phosphate solubilization by *Pseudomonas striata* (P_{27}) and *Bacillus polymxa* (H_5) (mean of six replicates)

Treatment	Halo size (mm)
Pseudomonas striata (P_{27})	8
P_{27} + *Cephalosporium* spp.	3
P_{27} + *Cephalosporium* spp. (ACF)	8
P_{27} + *Penicillium* (CF)	2
P_{27} + *Pencillium* (ACF)	8
P_{27} + *Trichoderma* spp. (CF)	8
P_{27} + *Trichoderma* spp. (ACF)	8
Bacillus polymxa spp. (H_5)	5
H_5 + *Cephalosporium* spp. (CF)	2
H_5 + *Cephalosporium* spp. (ACF)	4
H_5 + *Penicillium* spp. (CF)	4
H_5 + *Penicillium* spp. (ACF)	4
H_5 + *Trichoderma* spp. (CF)	3
H_5 + *Trichoderma* spp. (CF)	4

ACF = Autoclaved culture filterate; CF = Culture filterate

soluble 'P' irrespective of the source of inert phosphorus used. The results of this study indicates that not all the fungi isolated from seed surface cause the inhibition of P solubilization following bacterization with *Pseudomonas* spp. (P_{27}) or *Bacillus* spp. (H_5). In fact a combination of *Pseudomonas* spp. with *Aspergillus* spp. resulted in release of significantly higher amount of 'P' from TCP and MRP as compared to *Pseudomonas* spp. (P_{27}) alone. Culture filterates of two spermosphere fungal isolates namely, *Cephalosporium* spp. and *Pencillium* spp. showed maximum inhibition of 'P' dissolution as evident from halo zone studies (Table 2). This inhibition appears to be due to some metabolites synthesized by the fungi which is/are heat labile. Addition of autoclaved culture filterate was found to be ineffective in reducing the size of halo zone. Moreover culture filterates of *Trichoderma* spp. *Cephalosporium* spp. and *Penicillium* spp not only reduced the diameter of halo zone produced by P_{27} or H_5 on solid agar medium but also reduced the clarity of the halo zone so formed. Inocula on seed surface are exposed to number of toxic factors present on the seed coats which may determine the performance of the bioinoculant (Dadarwal and Sen, 1973). It may be concluded that one of the parameters which determines the efficacy of seed bacterization with phosphobacteria is the native seed coat microflora present on the surface of the seed.

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EFFECT OF NITROGEN AND BIOFERTILIZER ON GROWTH OF CARNATION (*DIANTHUS CARYOPHYLLUS* L.)

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Carrnation (*Dianthus caryophyllus* L.) occupies sixth position in world cut flower trade. They are highly valued for their attractive, array of colours and formation having long keeping quality. The dmand for cut flowers is increasing day by day. The cut flower of carnation with good quality and better yield can be obtained by cultural practices like irrigation, balanced use of fertilizers and growth substances.

A pot experiment was conducted at the Department of Horticulture, CCS Haryana Agricultural University, Hisar during 2004-05 to ascertain the effect of nitrogen and biofertilizers on growth of carnation cv. Red Corso. Carnation cuttings were planted in pots lined with polythene sheet. Carnation cuttings were dipped in *Azotobacter* strains, suspension for half an hour before planting in pots in the month of October. Five levels of nitrogen (0, 50, 100, 150 and 200 ppm) and five different strains of *Azotobacter* (0, HT-54, Mac-27, Mac-68 and MSX-9) and their combinations were applied. Staking was done with bamboo stick when plant attained 25 cm height for providing support to the plant so that plant can bear the weight of flowers. Final plant height was taken at 100 days after transplanting. Plant spread and number of branches per plant were recorded at 75 days after transplanting.

Plant height increased significantly with the increasing levels of nitrogen (Table 1). The maximum plant height was recorded where 150 ppm nitrogen was applied followed by 200 ppm of nitrogen. Plant height was minimum in control. The increase in plant height with nitrogen application might be due to the fact that nitrogen is constituent of protein which is essential for formation of protoplasm thus affecting the cell division and cell enlargements and ultimately better vegetative growth. Khattab *et al.* (1977) also reported that plant height increased with the application of nitrogen in carnation. Among the biofertilizers, maximum plant height was recorded in Mac-68 strain of *Azotobacter* followed by MSX-9. Among the interaction between nitrogen and biofertilizer, maximum plant height was recorded in 150 ppm N with Mac-68 followed by 200 ppm N with Mac-68. The increase in plant height with biofertilizer inoculation might be due to the fact that biofertilizer promotes root development and nitrogen uptake which results in increased vegetative growth.

Plant spread increased with increasing levels of nitrogen (Table 2). Maximum plant spread was found at 150 ppm nitrogen application and it was minimum in control. The increase in plant spread with the nitrogen application might be due to increase in vegetative growth as nitrogen is a component of chlorophyll, which result in more vegetative growth. Similar results have been reported by Patel and Arora (1983). Plant spread increased with the *Azotobacter* application. Maximum plant spread was recorded in Mac-68 followed by MSX9 and minimum in control. Biofertilizer increased nitrogenase activity resulting in more nitrogen fixation which lead to more vegetative growth. Among the interactions, maximum spread was recorded in Mac-68 with 150 ppm nitrogen while it was minimum in control, however, all treatment combinations were at par with each other.

The maximum number of branches were found where 150 ppm nitrogen was applied while it was minimum in control. Similar findings were reported by Bhattacharjee and Mukherjee (1976)

Table 1. Effect of nitrogen levels and *Azotobacter* on plant height, spread and branches/plant of carnation

N levels (ppm)			
0	29.43	15.63	1.45
50	31.31	16.91	2.49
100	36.23	17.69	2.47
150	39.34	19.27	3.76
200	38.36	19.05	3.55
CD at 5%	1.25	0.91	0.63
Azotobacter strains			
Control	28.47	14.95	2.10
HT-54	33.51	17.77	3.01
Mac-27	34.99	17.97	2.94
Mac-68	39.64	19.63	3.34
MSX-9	38.08	18.32	2.83
CD at 5%	1.21	0.90	0.63

The miximum number of branches per palnt were recorded in Mac-68 and minimum in control. Interaction between nitrogen and biofertilizer was non-significant for number of branches per plant.

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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON WHEAT (*TRITICUM AESTIVUM*) YIELD AND SOIL PROPERTIES

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The concept of integrated nutrient management seeks to sustain soil fertility through an integration of different nutrient sources and their application methods and produce maximum crop yield per unit input use (De Datta *et al.* 1990). Thus, the present experiment was undertaken to find out a suitable combination of locally available organic residue with inorganic fertilizer and its effect on sustainability of soil and wheat productivity.

Field experiment was conducted at Research Farm of the SKUAST-J, R.S. Pura during winter season of 2001-02. The soil of field was clay loam in texture, neutral in reaction (pH 6.64%), low in available nitrogen (218.4 kg/ha), medium in available phosphorus (16.6 k/ha) and low in available potassium (100.8 k/ha). The experiment was laid out in randomized block design with 3 replications. The treatments consisted of all possible combinations of three doses of inorganic fertilizers *viz.* 50, 100 (100 kg N, 50 kg P_2O_5 and 40 kg K_2O/ha) and 150% of recommended fertilizer dose (RDF) and five combination of three organic sources *viz.* FYM@5t/ha on oven dry weight basis, *Leucaena* biomass (Ls), paddy straw (Ps), FYM @ 2.5 t/ha + Ls and FYM @ 2.5 t/ha + Ps and one absolute control. The quantities of Ls and Ps when applied alone were decided on the basis of the equivalent amount of N supplied by 5 t FYM/ha whereas, their quantities were reduced to half when they were applied in combination with 2.5t/ha FYM. These organic residues were incorporated as per the treatment one day before the sowing of wheat crop. Half of the nitrogen in the form of urea and full doses of phosphorus and potassium as per treatment were applied at the time of sowing and remaining half nitrogen was top dressed in two equal splits, one at 30 days and the other at 60 days after sowing. The sowing and harvesting of wheat var. PBW-343 was done on 19 October, 2001 and 9 May, 2002, respectively. All other operations were performed as per the recommendations for the crop. The grain and straw samples were analysed for NPK content and total uptake was worked out. Soil samples (0-15 cm) were collected plot wise after wheat harvest and analysed for various soil properties by using standard methods.

The grain and straw yield of wheat increased significantly with the application of 150% RDF in combination with FYM and Ls (Table 1). The treatment T_{13} recorded higher grain and straw yield followed by T_4 and both were statistically at par with each other. This may be due to better availability of nutrients owing to combination of higher NPK (150% RDF) with organic sources. However, these treatments failed to show any significant effect on harvest index. Similar results were also reported by Rajender and Sanjeev Kumar (1997).

The uptake of N, P and K by wheat was greatly influenced by the INM treatments (Table 1). Significantly higher uptake of N, P and K was noticed in T_{13}. It was at par with T_4 and T_7. The balanced application of NPK at higher levels in combination with organic sources might have favourably influenced the plant growth and development resulting in higher yield. Due to higher yield of grain and straw, the crop removed larger quantities of nutrients (NPK) from the soil. These results are in close proximity with those reported by Yaduvanshi (2001).

Organic Carbon in general showed an improvement with the application of INM treatments (Table 2). The maximum value of soil organic carbon in surface layer (0-15 cm) was found in treatment T_{10} followed by T_9. This may

Table 1. Effect of INM treatments on yield harvest index NPK uptake by wheat and their available sld is in soil

Treatment	Yield (kg/ha)		Harvest Index %	Nutrient uptake (kg/ha)		
	Grain	Straw		N	P	K
T_1= Control	2262	4118	35.44	39.75	6.99	72.70
T_2= FYM (5t) + 50% RFD	2716	4584	37.20	52.70	8.84	91.15
T_3= FYM (5t) + 100 % RFD	3417	5721	37.38	77.72	11.86	115.5
T_4=FYM (5t) + 150 % RFD	4041	6343	38.92	97.08	13.93	131.0
T_5= Ls + 50% RFD	2579	4474	36.56	50.33	8.35	88.41
T_6=Ls + 100% RFD	3233	5629	36.48	70.63	11.13	112.0
T_7= Ls + 150% RFD	3937	6200	38.83	94.58	13.59	127.9
T_8=Ps + 50% RFD	2329	4322	36.65	44.91	7.54	79.23
T_9=Ps + 100% RFD	2950	5041	36.91	97.76	9.90	100.3
T_{10}= Ps + 150% RFD	3346	5667	37.10	73.97	11.37	114.0
T_{11}=FYM (2.5t) + Ls + 50% RFD	2971	5086	36.87	62.48	9.99	101.1
T_{12}=FYM (2.5t) + Ls + 100% RFD	3279	5644	36.74	71.59	11.50	112.8
T_{13}=FYM (2.5t) +Ls + 150% RFD	4229	6384	39.83	100.9	14.47	132.9
T_{14}=FYM (2.5t) + Ps + 50% RFD	24.96	4368	36.35	47.85	7.93	85.14
T_{15}= FYM (2.5t) + Ps + 100% RFD	3075	5270	36.82	65.48	10.47	105.0
T_{16}=FYM (2.5t) + Ps +150% RFD	3571	5858	37.87	83.02	12.4	119.8
CD (P=0.05)	299	247	NS	6.50	0.85	8.38

Table 2. Effect of INM treatments on soil properties and available N, P, K in soil

Treatment	OC (%)	Available Nutrients (kg/ha)		
		N	P	K
T_1= Control	0.44	185.4	15.16	95.61
T_2= FYM (5t) + 50% RFD	0.48	208.2	16.70	108.9
T_3= FYM (5t) + 100 % RFD	0.50	228.4	18.10	111.4
T_4=FYM (5t) + 150 % RFD	0.53	242.0	21.21	126.6
T_5= Ls + 50% RFD	0.46	204.3	17.16	103.7
T_6=Ls + 100% RFD	0.48	233.2	18.26	108.3
T_7= Ls + 150% RFD	0.47	235.8	20.17	118.5
T_8=Ps + 50% RFD	0.52	198.5	16.51	107.8
T_9=Ps + 100% RFD	0.54	215.9	17.88	111.6
T_{10}= Ps + 150% RFD	0.56	226.1	18.90	120.3
T_{11}=FYM (2.5t) + Ls + 50% RFD	0.48	216.9	17.82	105.3
T_{12}=FYM (2.5t) + Ls + 100% RFD	0.50	224.9	18.52	111.3
T_{13}=FYM (2.5t) +Ls + 150% RFD	0.49	241.0	20.75	124.2
T_{14}=FYM (2.5t) + Ps + 50% RFD	0.52	201.7	16.95	115.3
T_{15}= FYM (2.5t) + Ps + 100% RFD	0.52	220.6	18.12	117.9
T_{16}=FYM (2.5t) + Ps +150% RFD	0.50	232.4	20.00	128.4
CD (P=0.05)	NS	7.76	1.79	5.72

be due to incorporation of high C:N ratio organic residue *viz.* paddy straw in soil. INM treatments significantly improved the N, P and K status of soil over control. Significantly higher available N and P in soil was noticed in treatment T_4. However, higher available K in soil was noticed in T_{16} which was statistically at par with T_4 and T_{13}. The build up in available N, P and K status of soil may be due to solubilizing action of certain organic acids produced during the decomposition of organic source.

Thus, application of higher and balanced doses of inorganic fertilizer in combination with organic sorces having low C:N ratio viz. (FYM and Ls) significantly increased grain and straw yield, nutrient uptake and nutrient status of soil.

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EFFECT OF FERTILIZER LEVELS ON YIELD ATTRIBUTING CHARACTERS OF RELAY CROPS IN RICE

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Relay cropping is profitable under rainfed condition. In Assam, relay cropping of pea, khesari and linseed is commonly practiced in *sali* rice field of lower Brahmaputra valley zone as well as some pockets of other agro climatic zones of Assam. The growth and yield of these crops under relay cropping is very poor mainly due to lack of proper fertilization (Dutta, 1993 and Kalita, 1999). Evaluation of optimum levels of fertilizer for relay crop is, therefore, is very much required. Which hitherto lacking in Assam. Therefore the present study was under taken.

Field experiment was conducted at Instructional-cum-Research Farm, Assam Agricultural University, Jorhat during *kharif* and *rabi* season of 2001-02. The soil of experimental site was acidic, sandy loam in texture with pH 5.4, organic carbon (0.65%) and available N (285.89 kg/ha), P_2O_5 (26.45 kg/ha) and K_2O (147.84 kg/ha). The experiment was laid out in factorial randomization block design with twelve treatment combination and three replications. The fertilizer doses was applied on relay crops at 50, 75, 100 and 125 per cent recommended levels of fertilizer for linseed, pea and khesari were 40-20-10, 20-40-10 and 20-40-10 N-P_2O_5-K_2O kg/ha, respectively. All P and K and half doses of N as per treatment were applied at sowing of relay crops. The remaining half doses of N were splited in to two equal doses and top dressed at 30 and 45 days after sowing of relay crops. The rice variety 'Ranjit' was grown as per recommended practices. Linseed (var. T-397), pea (var. T-163) and khesari (var. LSD-3) were sown in the standing rice field 18 days before the harvest of rice.

The plant height and number of branch/plant at harvest and number of capsule or pod/plant of relay crops were significantly influenced by different treatments. The highest plant height, number of branch/plant at harvest and number if capsule or pod/plant was recorded at 125 per cent recommended levels of fertilizer (Table 1) and was found statistically at par with 100 per cent recommended levels of fertilizer. The interaction effect of relay crops and fertilizer levels was found to be significant. The highest plant height, number of branch/plant at harvest, number of capsule or pod/plant was recorded at 125 per cent recommended levels of fertilizer in all the relay crops (Table 2). This might be due to the higher availability of nutrients to the crops. Different levels of fertilizer did not produce any significant effect on plat density/m^2, number of seed/pod and test weight of relay crops.

Table 1. Yield attributing character of relay crops and availability of nutrient in soil as influenced by fertilizer levels

Treatment	Plant height (cm)	No. of branch/ plant	Plant density/m^2	No. of pod/plant	No. of seed/pod	Test weight (cm)	Available N(kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Linseed	44.08	5.42	74.53	21.81	9.15	5.48	205.04	21.74	95.90
Pea	76.67	6.40	53.33	4.48	5.18	251.5	209.26	25.72	109.95
Khesari	61.39	6.53	88.32	23.52	3.18	51.28	210.58	23.73	105.57
S.Ed (±)	0.28	0.07	0.65	0.20	0.05	0.17	0.11	0.02	0.01
C.D. 0.05	0.57	0.14	1.35	0.42	0.11	0.35	0.24	0.04	0.03
Fertilizer levels: N-P_2O_5-K_2O									
50%	55.61	5.06	71.22	14.82	5.79	102.52	193.78	20.96	92.17
75%	59.02	5.85	71.78	16.11	5.82	102.67	203.44	22.91	99.72
100%	63.89	6.69	72.33	17.60	5.86	102.83	214.69	25.14	108.99
125%	64.32	6.86	72.89	17.89	5.89	102.99	221.27	25.90	114.35
S.Ed (±)	0.32	0.08	NS	0.23	NS	NS	0.13	0.02	0.02
C.D. 0.05	0.66	0.17	NS	0.48	NS	NS	0.27	0.05	0.03

Table 2. Yield attributing character of relay crops due to interaction of different fertilizer levels

Fertilizer level (N-P_2O_5-K_2O)	Plant height (cm)			No. of branch/plant			No. of pod/plant		
	Linseed	Pea	Khesari	Linseed	Pea	Khesari	Linseed	Pea	Khesari
50%	40.25	71.44	55.13	4.18	5.53	5.47	20.30	4.13	20.03
75%	42.48	76.20	58.38	5.00	6.37	6.17	21.52	4.33	22.47
100%	46.71	79.06	65.92	6.17	6.79	7.12	22.65	4.57	25.57
125%	46.88	79.97	66.12	6.31	6.92	7.3	22.78	4.88	26.00
Mean	44.08	76.68	61.39	5.42	6.40	6.52	21.81	4.48	23.52
S. Ed (±)	0.55			0.14			0.40		
C.D. 0.05	1.15			0.29			0.84		

Table 3. Available nutrients in soil due to interaction of different levels of fertilizer

Fertilizer level (N-P_2O_5-K_2O)	Available N			Available P			Available K		
	Linseed	Pea	Khesari	Linseed	Pea	Khesari	Linseed	Pea	Khesari
50%	191.54	191.54	198.25	18.74	23.36	20.79	88.03	96.32	92.17
75%	200.95	204.35	205.01	20.63	25.65	22.46	92.17	105.28	101.71
100%	209.21	217.43	217.43	23.35	26.50	25.56	98.56	116.48	111.93
125%	218.47	223.71	221.62	24.23	27.36	26.10	104.85	121.73	116.48
Mean	205.04	209.26	210.58	21.74	25.72	23.73	95.90	109.95	105.57
S.Ed (±)	0.23			0.04			0.03		
C.D. 0.05	0.47			0.09			0.06		

Available N, P and K significantly differed due to different levels of treatments (Table 1). The highest available N, P and K in regards to the relay crop were recorded in 125 per cent recommended levels of fertilizer and these was superior to all other treatments.

The interaction effect of relay crops and fertilizer levels was found to be significant (Table 3). The highest available N, P and K was recorded at 125 per cent recommended levels of fertilizer, which might be due to the incorporation of higher levels of more N enriched root mass of relay crops.

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RESPONSE OF WHEAT (*TRITICUM AESTIVUM*) TO NITROGEN AND ZINC APPLICATION

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A field experiment was conducted during winter season of 2003 on cultivar U.P. 2338 with three levels of nitrogen viz. 0, 75 and 100 kg/ha and 3 levels of zinc viz. 0, 5 and 10 kg/ha in randomized block design (RBD) with three replications, at the Research Farm of the A.S. College, Lakhaoti. The soil was sandy loam with pH 7.3, organic carbon content 0.33%, available P content 9.2 kg/ha. Seeds were sown at a depth of 4-5 cm @ 100 kg/ha in 20 cm rows. Urea (46% N) was used as source of nitrogen and zinc sulphate (33% Zn) was used as the source of zinc. Half of the recommended nitrogen and full dose of zinc was applied at the time of sowing and remaining nitrogen and applied in two equal doses at tillering and joining stage.

There was progressive increase in the plant height of the wheat from control to 100 kg/ha. Both 75 kg N/ha and 100 kg N/ha produced significantly higher plant height as compared to control. Same trend was observed for number of leaves per plant and dry matter accumulation (g/plant). Sushila and Giri (2000) also reported similar results with regard to plant height, number of leaves per plant and dry matter accumulation. This could be the result of increased growth rate achieved by the application of nitrogen. Yield contributing characters like number of tillers per plant and 1000-grain weight were affected significantly by the application of 100 kg N/ha and was superior as compared to control and 75 kg N/ha (Table 1). This might be attributed to the fact that application of 75 kg N/ha and native nitrogen of the field was not sufficient to meet the requirement of crop plants. Increase in yield components due to application of nitrogen could be the result of increased overall growth of plants achieved by the faster cell division and cell elongation and higher net photosynthesis. Grain yield of 37.2 q/ha was produced by the application of 100 kg N/ha and it was significantly higher as compared to the rest of treatments. This could be the result of an increase in yield contributing characters obtained by the increased transfer of photosynthates from source to sink.

Growth parameters like plant height, number of leaves/plant and dry matter

Table 1. Performance of wheat as affected by levels of nitrogen and zinc

Treatment	Plant height (cm)	Number of leaves/ plant	Dry matter accumulation (g/plant)	Number of tillers /plant	1000-grain weight (g)	Grain yield (q/ha)	Straw yield (q/ha)
N (kg/ha)							
Control	66.72	6.89	21.92	3.05	33.27	18.60	22.61
75	78.64	8.00	24.24	3.79	34.73	28.31	33.44
100	87.02	8.67	25.24	5.44	36.99	37.19	43.42
CD (P = 0.05)	1.48	0.60	0.28	0.21	0.10	0.96	0.10
Zn (kg/ha)							
Control	71.71	7.89	23.54	3.78	34.64	27.30	32.45
5	78.65	8.00	23.98	4.24	35.11	28.73	33.73
10	78.17	7.67	23.88	4.26	35.18	28.06	33.29
CD (P = 0.05)	1.48	0.60	0.28	0.21	0.10	0.96	0.37

accumulation were not affected by zinc levels. Yield contributing characters like number of tillers per plant and 1000 - grain weight increased by the application of zinc upto 5 kg/ha only and further increase could not bring significant change in yield contributing characters. Grain yield of wheat also increased by the application of zinc 5 kg/ha significantly as compared to control (Table 1). This might be the result of favourable effect of zinc o the metabolic reactions. Such type of findings were also reported by Mishra and Mehrotra (1986).

On the basis of this study it can be concluded that application of 100 kg N/ha and 5 kg Zn/ha to wheat variety UP 2338 results in higher yield of crop under western Uttar Pradesh conditions.

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WEED MANAGEMENT STUDIES IN LENTIL (*LENS CULINARIS* MEDIK)

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Lentil (*Lens culinaris* Medik) is an important winter season pulse crop in India. It is hardier and capable of withstanding extremes of weather and soil conditions. However, due to its short stature, slow initial growth and long duration, its productivity is adversely affected by the presence of weeds. As per an estimate the reduction in yield may be up to 74% (Balyan *et al.*, 1997). Hand weeding and hoeing are the conventional and more effective practices of weed removal in pulses. These practices have certain limitations like non-availability of labourer at right time and higher wages. Under such situation the use of selective herbicides may provide more effective and economical control of weeds as compared to manual weeding.

A field experiment with 8 treatments was conducted at Crop Research Center of G.B. Pant University of Agriculture & Technology, Pantnagar during *rabi* 2001-02 and 2002-03. The soil of the experimental plot was sandy loam with medium fertility and had a pH 7.2. Eight treatments *viz.* weedy check, fluchloralin @ 0.5, 1.0 kg/ha as PPI, isoproturon 0.5 and 1.0 kg/ha as PE, pendimethalin 0.5 and 1.0 kg/ha as PE, hand weeding at 20 and 45 days after sowing were tested in randomized block design with three replications. Lentil variety 'PL-4' was sown at 30 cm apart in rows during 2nd week of November. Crop was uniformly fertilized with 100 kg di-ammonium phosphate at the time of sowing. All the herbicides were applied with flat fan nozzle by foot sprayer using 600 l water/ha. Fluchloralin was Applied to 2-3 cm upper soil layer before crop sowing while pendimethalin and isoproturon were applied as pre-emergence sprays. Endosulfan was sprayed twice @ 1.5 l/ha to control catter pillers.

Dominant weed species in the experimental field were *Anagallis arvensis, Coronopus dedymus, Erigeron canadensis* and *Phalaris minor*. Minor weeds (*Chenopodium album, Melilotus alba*) were put in the category of other weeds. Total number of weeds were reduced significantly in all the treatments as compared to untreated check during both the years, except foucholoralin 0.5 kg/ha, isoproturon 0.5 and 1.0 kg/ha during 2001-02 and in isoprotuton at 0.5 kg/ha during 2002-03. Weed population was highest at 73.3 and 85.5 /m^2 in weedy check during 2001-02 and 2002-03, respectively. Among all the herbicides weeds were controlled effectively by pendimethalin at 1.0 kg/ha applied as pre-emergence as compared to isoproturon 0.5 and 1.0 kg/ha during both the years (Table 1). *Anagallis arvensis* was reduced significantly by fluchloralin and pendimethalin during both the years. *Coronopus dedymus* was not controlled by fluchloralin 0.5 or 1.0 kg/ha and pendimethalin 0.5 kg/ha during both the years, however the difference were found significantly different during 2003, only. *Phalaris minor* was controlled significantly in all the treatments over weedy check during both the years. Similar results were also obtained by Singh and Sardana (2001). Dry matter accumulation was also influenced significantly in all the treatments as compared to weedy check during both the years. Weed dry matter was also reduced with the increases in herbicidal level from 0.5-1.0 kg/ha during both the years. Reduction in weed dry matter due to trifluralin, pendimethalin was also reported by Balyan *et al.* (1997). Highest weed control efficiency (WEC %), of 97.6 % during 2001-02 and 95 % during 2002-03 was recorded in two hand weeded plots followed by 94.7 % in fluchloralin 1.0 kg; 88 % in pendimethalin 1.0 kg during 2001-02 and 92 %, in pendimethalin 1.0 kg/ha and 88 % in fluchloralin 1.0 kg/ha (Table 1). Proper weed management was

Table 1. Weed population (m^{-2}), dry matter of weeds (gm^{-2}) WCE (%) ; grain and yield attributes and yield of lentil as influenced weed control treatments

Treatments	Rate and time of application	Total no. weeds/m^2		Other weeds		Dry matter of weeds (g/m^2)		WCE (%) at 60 DAS		Crop plant / m row length (30 DAS)		Plant height cm. (60 DAS)		Dry weight of crop plant / m row length (60 DAS)		No. of pods/ plant		Grain yield (kg/ha)	
		01-02	02-03	01-02	02-03	01-02	02-03	01-02	02-03	01-02	02-03	01-02	02-03	01-02	02-03	01-02	02-03	01-02	02-03
Weedy check	-	73.3	80.5	2.7	9.3	38.0	45.3	0.0	0.0	71.7	68.3	13.9	14.2	14.3	15.5	50.2	65.0	28.5	31.5
Fluchloralin	0.5kg/ha PPI	36.0	38.5	5.3	7.9	6.8	10.4	82.1	77.0	63.0	65.5	12.9	12.8	15.8	16.8	82.5	92.0	455	346
Fluchloralin	1.0 kg/ha PPI	24.0	21.5	2.7	1.6	2.0	5.3	94.7	88.3	41.3	45.5	9.0	8.3	13.8	14.3	115.0	127.0	565	625
Isoproturon	0.5 kg/ha PE	74.7	70.5	8.0	0.0	22.0	25.2	41.6	43.7	67.7	70.4	15.6	14.5	17.0	18.5	131.0	111.5	415	340
Isoproturon	1.0 kg/ha PE	60.7	42.8	4.0	3.0	18.6	20.6	50.5	54.5	69.7	72.5	15.9	15.6	19.9	20.5	130.0	122.5	560	415
Pendimethalin	0.5 kg/ha PE	24.0	24.5	1.3	0.0	7.8	8.8	79.5	80.5	72.7	70.5	16.1	17.2	25.3	23.4	150.0	152.0	820	855
Pendimethalin	1.0 kg/ha PE	10.7	8.8	1.3	2.0	4.5	3.6	88.1	92.0	84.3	80.3	16.1	16.5	25.9	25.6	159.0	162.0	940	1020
Hand weeding (20+45 DAS)		21.7	20.5	2.7	2.4	0.9	2.0	97.6	95.6	98.3	28.5	16.6	17.8	30.5	28.4	165.5	162.0	1025	1065
CD at 5%		40.0	38.5	NS	NS	1171	12.3	-	-	27.8	20.5	3.4	3.6	10.6	11.3	67.5	71.0	255	310

reflected by grain yield of lentil. Grain yield of lentil was significantly higher in two hand weeding (20 and 45 DAS) over weedy check, fluchloralin and isoproturon at both the rates of 0.5 and 1.0 kg/ha, during both the years. The grain yield was found non-significant when compared with pendimethalin at both the rates during both the years. Higher pods per plant and comparatively bolder seeds reflected the higher grain in two hand weeded treatment as compared to rest of the treatments. The similar effects were also reported by Singh and Singh (1985). The plant stand was lowest in fluchloralin @ 1.0 kg/ha. Due to its toxic effect the plant height, dry matter and primary branches were affected, however 1000 grain weight, pods/plant and grain yield were higher at this rate as compared to 0.5 kg/ha.

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EFFECT OF PLANT DENSITIES AND PHOSPHORUS LEVELS ON GROWTH AND YIELD OF GREEN GRAM (*VIGNA RADIATA* L.)

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Optimization of pant density with suitable inter and intra row spacing is essential for newly developed genotypes of greengram which are high yielding and resistant to powdery mildew and mosaic. The low productivity is also due to inadequate supply of nutrients, as most of the Indian soils are deficient in phosphorus. Its deficiency is usually the most important single factor, responsible for poor yield of green gram on all soil types. Considering the above facts, this study was undertaken.

A field experiment was conducted on clay soil at the experimental farm of Department of Agronomy, Marathwata Agricultural University, Parbhani (Maharashtra) during *kharif* 2003. The soil of the experimental field was alkaline in reaction (pH 8.3), deficient in total nitrogen (0.056%), medium in available phosphorus (19.92 kg/ha) and potassium (232.96 kg/ha). There were 12 treatment combinations replicated 4 times in split-plot design. The main plot treatments consisted of four combinations of two inter row (30 cm and 45 cm) and intra row (10 cm and 15 cm) spacings, while, the sub-plot treatments consisted of 3 levels of phosphorus *viz.*, 25, 50 and 75 kg P_2O_5/ha. The green gram variety 'BPMR-145' was sown in row as per treatments. Phosphorus as per treatments through SSP and a uniform dose of 25 kg N/ha was supplied through urea as a basal dose at 5 cm below the seedling depth before sowing.

The inter row spacing of 45 cm recorded significantly higher dry matter per plant than 30 cm. This might be due to relatively higher growth resources (nutrient, moisture and space) available under wider row spacing. The number pods/plant, pod weight/plant, grain weight/plant were higher with 45 cm spacing, which may be explained in term of rapid growth, more branching and dry matter production. The inter row spacing of 30 cm recorded significantly higher grain yield (8.82 q/ha), straw yield (33.83 q/ha) and harvest index (21.06%) as compared to 45 cm spacing (Table 1). This might be due to less availability of space under dense plant population, suppressing individual plant growth. Similar findings have also been reported by sekhon *et al.* (2002).

The intra row spacing 15 cm recorded significantly higher dry matter accumulation number of pods/plant, pod weight/plant, and grain weight /plant over 10 cm spacing. This could be attributed to beneficial effect of space (Prasad and Yadav, 19990). Grain yield and straw yield were significantly higher with 10 cm intra row spacing over 15 cm row spacing (Table 1). This could be due to more number of plants/unit area which compensated the low yield per plant under high plant density. Similar findings were also reported by Kumar *et al.* (1993).

Application of 75 kg P_2O_5/ha significantly increased the dry matter accumulation/plant, number of pods/plant, pod weight/plant and grain weight/plant (Table 1). The increase might have been on account of stimulation of root growth of the crop as phosphorus plays an important role in various physiological process including root development, nodulation and N-fixation. Similar findings have also been reported by Shukla and Dixit (1996). Application of 75 kg P_2O_5/ha significantly enhanced grain yield (8.97 q/ha), straw yield (33.42q/ha), biological yield (42.61 q/ha) and protein content over 25 and 50 kg P_2O_5/ha (Table 1). This might be due to increase in yield attributes due to vital role of phosphorus in energy transformation and metabolic process

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QUALITY PARAMETERS OF IRRIGATION WATER IN SOME MINOR LIFT IRRIGATION SCHEMES AND THEIR IMPACT ON PHYSICO-CHEMICAL PROPERTIES AND NUTRIENT STATUS OF SOILS

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Due to increasing demand of water for various purposes, use of poor quality water for irrigation and consequently its judicious management, becomes inevitable in certain regions. Sometimes poor quality water is the only available source for irrigation. There are twelve minor lift irrigation schemes in operation in the fringe areas of Ranvir canal command, south of Jammu city, some of them on perennial nallahs which are fed partly by municipal waste water or industrial effluents and partly by seepage/ drainage from higher elevation and some of them on distributaries of Ranvir canal, catering to irrigation needs of agricultural land of 35 to 100 ha of each for the past two decades. Though, irrigation needs of agriculture originally help to harvest bumper crop, it increases soil salinity and has other deleterious effect on soil characteristics. There is a general decline in crop yield under aforesaid minor lift irrigation schemes. In view of this, present investigation was undertaken.

The study area comprising two minor lift schemes, one on "Bhor" nallah fed mainly by municipal wastes for the past two decades and industrial effluents for the past one decade having cultural command area about 38 ha and the other at Chatha farm area beyond the confluence of Bhor and Balol nallahs, but mainly fed by industrial effluents from the industrial areas having cultural command areas of about 60 ha have been identified for the study. In addition, a third minor lift scheme at Gidergalian, lifting good quality irrigation water from distributory No. 10 on Ranvir canal and feeding about 100 ha of fringe area beyond the cultural command area of the distributory command has also been chosen for comparison, during 2000-05. Climatic zone of study area is low altitude subtropical zone, with an average rainfall of 1260 mm, two third of which is in the *kharif* months of July, August and September. The atmospheric temperature ranges from 0 to 40 °C. surface soil texture ranges from sandy loam to silt loam and profile generally homogeneous upto 2 m depth. Irrigation water samples in monthly frequency at the take off points as well as at mid section and tailend of command of all these three schemes were collected and analyzed for standard water quality parameters by following standard methods (USS Staff, 1954) at water quality laboratory of National Institute of Hydrology, Western Himalayan Region Centre, Jammu. The quality parameters analyzed were pH, EC, SAR, MH and RSC. The soil samples from these concerned command and adjoining areas of non command were also collected and analyzed for important physico-chemical properties and available N, P and K of status by following standard method (Jackson, 1978).

The results pertaining to water quality indicates that pH values in all the water samples lie with in the safe range of pH 6.5 to 8.5 except in a couple of samples viz. at Chatha-2 (8.98) and Chatha-3 (8.68) which corresponds to non-rainy lean period with higher concentration of non effluents in water of Chatha LIS. The electrical conductivity of all the three sites ranged from 0.458 to 4.925 with mean value of 1.491, 0.497-1.551 with mean value of 1.027 and 0.209-0.552 with mean value of 0.306 ds/m at Bhor, Chatha and Gidergalian respectively (Table 1). Electrical conductivity also varied with different time intervals. The values were higher in the months of January and February and lower in the months of September at all the locations. The increasing salinity in irrigation water of about 85% samples at Bhor LIS, 76% samples at Chatha LIS and 7% at Gidergalian LIS, respectively. The levels of salinity at Bhor LIS and Chatha might be due to intake of municipal cum industrial waste water. The SAT values of water samples ranged from 0.41 to 0.44 with mean value of 0.83, 0.17 to 1.11 with average value of 0.59 and 0.10 to 0.44 with mean value of 0.16 at Bhor, Chatha and Gidergalian, respectively. As values of SAR fall below the prescribed limit of 10.0, irrigation water of all the study sites could be classified as in excellent category. The magnesium hazards (MH) ranged from 24 to 65 with mean value of 46, 34 and 89 with mean value of 58 and 23-72 with mean value of 48 me/l at Bhor, Chatha and Gidergalian, respectively. The effect of magnesium hazards are considered to be harmful, where MH > 50 me/l (Pitchaiah, 1975). In this study, majority of water samples (65%) collected from municipal cum industrial waste water used for irrigation at Chatha LIS lie under the harmful class of magnesium hazards. The values of residual sodium carbonate ranged from 0.24 to 2.96 with average of 1.32, 0.22-3.32 with mean value of 1.08 and 0.01-1.98 with mean value of 0.62 me/l at Bhor, Chatha and Giderfgalian, respectively. In this study majority of water samples from all the sites lie under the safe category as per the limit of RSC < 1.25 me/l as proposed by Eaton (1950).

The soil texture of all the four sites varied from sandy loam to silt loam. The silt loam texture of majority of soil samples at Gidergalian and Dharap might be due to heavy siltation in soils through irrigation water of Ranvir canal. Whereas sandy clay loam texture was noted in non command areas of these two locations owing to use of silt free ground water for irrigation. The soil pH of all the four locations varies from 6.5 to 7.5. In general, the values were higher at Bhor and Chatha soils as compared to Gidergalain and Dharap. It might be due to use municipal cum industrial waste water at Bhor and Chatha. The pH values of soils of non command areas were higher than the command areas. It might be due to moisture stress in non command soils resulting in OH ions on soil surface in non commands soils. The surface soils showed higher value of pH over subsurface soils. In general EC values of soils of command were higher over the soils of non command. The EC

Table 1. Irrigation water quality parameters of study areas

Sampling date	Bhor Camp				Chatha				Gidargalian			
	EC	SAR	MH	RSC	EC	SAR	MH	RSC	EC	SAR	MH	RSC
17-01-00	1.701	0.82	39	2.47	1.213	0.48	34	0.71	0.552	0.13	72	0.74
18-02-00	1.543	0.91	46	1.47	1.248	0.47	63	0.54	0.524	0.15	65	0.81
30-03-00	1.812	0.37	45	1.81	1.160	0.17	89	1.42	0.415	0.11	52	0.98
08-05-00	1.914	0.41	46	0.74	1.202	0.16	87	0.22	0.306	0.10	45	1.98
08-06-00	1.567	0.81	59	2.96	0.955	0.41	70	3.32	0.031	0.11	50	0.01
17-07-00	1.430	0.64	65	1.24	0.900	1.06	46	1.80	0.214	0.13	23	0.38
21-08-00	1.430	1.08	47	0.08	0.895	0.70	61	0.29	0.295	0.11	36	0.27
26-09-00	0.458	0.54	41	0.98	0.417	0.64	38	0.76	0.209	0.16	39	0.45
03-11-00	0.516	1.53	24	0.90	0.592	1.11	50	0.72	0.320	0.44	34	0.05
21-12-00	1.805	0.79	56	1.67	1.551	0.67	45	0.65	0.422	0.19	61	0.59
27-02-01	1.925	1.29	38	0.24	1.163	0.67	50	1.50	-	-	-	

values of Bhor and Chatha soils of command were higher than the soils of Gidergalian and Dharap. Surface soils of Bhor and Chatha showed higher values of EC than the subsurface soils whereas opposite trend was noted in soils of Gidergalian and Dharap. The surface soils showed higher content of organic carbon in comparison to subsurface soils. The values of OC were higher in soils of Bhor and Chatha when compared with Gidergalian and Dharap. The higher content of organic carbon was noted in soils of non command over command at Dharap and Gidergalian whereas reverse trend in organic carbon distribution was observed in soils of Bhor and Chatha. The higher content of available N and P_2O_5 was recorded in surface soils over subsurface soils. The soils of command areas showed higher content of available N and P_2O_5 as compared to non command at Bhor and Chatha, whereas a reverse trend was observed in soils of Gidergalian and Dharap. The available K_2O content in general was higher in soils of Bhor followed by Chatha, Gidergalian and Dharap. The soils of command areas showed higher content of K_2O over non command at Chatha and Bhor, whereas opposite trend was found in available K_2O content at Gidergalian and Dharap. The increasing levels of available K in sub soils of Gidergalian and Dharap might be due to leaching of K in light textured soils.

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BHENDI GENOTYPE IDENTIFICATION BASED ON SEED CHARACTERS

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ABSTRACT

Twelve genotypes including two local types from Kudiatham and Nagercoil were utilized to study various characters for the identification of different varieties in bhendi based on seed characters. In seed measurements the seed of Nagercoil Local and Parbhani and Pusa Sawani recorded maximum and minimum seed length, respectively. Arka anamica register higher seed breadth and it was lower in Kudiatham local and CO3. The seed thickness is higher for the seeds of Arka anamica and Nagercoil local. In seed coat colour, Arka anamica shows distinct olive green. The varieties, Pusa sawani, Punjab padmini, CO2 and Nagercoil local have green seed coat and other varieties have grayish green seed coat. The 100-seed weight is the highest for Nagercoil and the lowest in CO1 and Pusa Makhmali. In addition of the above the varieties could be categorized based on the contribution of embryo, oil and protein content of seeds.

Key words : Genotypes embryo, protein, seed size.

The stupendous effort of plant breeders in recent years had led to the evolution of new high yielding varieties and this in turn has led to the need for testing of cultivars for their identity, so as to keep their purity standards. According to Brickell *et al.* (1980) the international term 'Cultivar' distinguished by any characters (Morphological, Physiological, Chemical or other) and when it reproduced (sexually/ asexually) retains its distinguishing traits so that the genetic potential of the cultivar in terms of yield and quality could be achieved.

In laboratory method, using seed characters is helped in varietal identification, so as to avoid admixtures with other varietal seeds. This will indirectly be helpful to maintain genetic purity in subsequent generations. Thus the present study was carried out for varietal identification in bhendi based on seed characters.

MATERIALS AND METHODS

In this study, twelve genotype were used including two local cultivars. The varieties CO1, CO2, CO3, MDU1, AE 180, Pusa sawani, Pusa makhmali, Punjab padmini, Parbhani kranti and Arka anamica were obtained from Horticultural College & Research Insitute, Coimbatore and the two local cultivars were collected from Kudiatham and Nagercoil. The following attributes were assessed.

1. Seed coat colour - Based on the visual scoring on seed coat colour the varieties were grouped into three *viz.*, olive green, green and grey or grayish green.
2. Seed size - 20 seeds in each variety and cultivar were picked at random and with the help of a screw gauge, measurements were made between (i) the top and bottom of the seed above and below the hilim, (ii) hilum and the convex dorsal side of the seed and (iii) the two lateral sides parallel to the length of hilum and recorded as the length, breadth and thickness of the seed, respectively the mean values were expressed in mm.
3. 100-seed weight (Anon, 1999), percentage of embryo and seed coat, seed coat / embryo ratio (dividing the weight of seed coat by that of embryo), protein content (Ali-Khan and Youngs, 1973) and oil content (Christiansen and Moore, 1961).

RESULTS AND DISCUSSION

The varietal description provided by the concerned breeders are generally inadequate to characterize a variety or varietal mixture, particularly at seed level or in the loboratory level. Therefore, it is of paramount importance to develop keys to identify varietal purity based on the characteristics of seed in the laboratory and this will facilitate a quick and effective check on the quality of seed moving in the commercial channels.

In the present investigation based on the seed coat colour, genotypes viz., Pusa sawani, Punjab padmini, CO2 and Nagercoil have green seed coat colour, the variety Arka anamica have distinct olive green and remaining other varieties have grayish green seed coat colour. Similar seed coat colour variations were reported by Deynze and Pauls (1994) in brassica species.

The genotypes were further measured for seed length, breadth and thickness and grouped

Table 1. Characters of varieties based on seed measurements and contribution of seed components

Varieties	Length (mm)	Breadth (mm)	Thickness (Mm)	Embryo (g)	Seed coat (g)	Embryo (%)	Seed coat (%)	Seed coat embryo ratio
CO1	4 25	4.68	3.95	2.91	3.13	48.53	51.47 (44.16)	1.04 (45.84)
CO2	4 39	4.71	4.05	3.15	3.27	50.04	51.47 (45.02)	1.00 (45.84)
CO3	4 31	4.04	3.93	3.08	3.72	48.87	49.96 (44.35)	1.06 (44.98)
MDU 1	3 37	4.82	3.72	3.10	3.12	49.94	51.13 (44.97)	1.00 (45.65)
AE 180	4 52	4.73	3.97	3.20	3.32	49.16	50.06 (44.52)	1.04 (45.03)
Pusa sawani	4 13	4.95	3.99	3.21	3.14	50.02	49.47 (45.58)	0.98 (44.69)
Pusa Makhmalli	4 23	4.68	4.01	3.07	22.93	51.02	48.98 (45.58)	0.96 (44.42)
Punjab Padmini	4 43	4.71	4.06	3.45	3.56	49.26	50.74 (44.58)	1.03 (45.42)
Parbhani Kranti	3.93	5.46	3.89	3.22	3.17	48.46	51.54 (44.12)	1.07 (44.58)
Arka Anamica	4.64	5.31	4.33	3.40	3.32	50.65	49.35 (45.37)	0.96 (44.63)
Kudiatham Local	4.61	4.24	3.85	2.96	3.20	48.02	51.98 (43.86)	1.08 (46.14)
Nagarcoil Local	4.98	4.80	4.37	3.56	3.91	47.64	52.36 (43.65)	1.10 (46.35)
C.D. (P=0.05)	0.2801	0.5031	0.3594	0.35799	0.40788	0.6984	1.0439	0.0510

Table 2. Characterization of varieties based on seed weight and chemical composition

Varieties	100 seed weight (g)	Oil (%)	Protein (%)
CO1	6.0388	16.4	19.15
CO2	6.3248	15.6	18.26
CO3	6.2969	16.0	18.06
MDU 1	6.2154	15.8	18.36
AE 180	6.5223	15.1	19.48
Pusa Sawani	6.3499	14.2	17.72
Pusa Makhmalli	6.0018	17.9	20.71
Punjab Padmini	6.9659	14.0	17.86
Parbhani Kranti	6.6250	16.7	20.60
Arka Anamica	6.7191	17.2	18.00
Kudiatham Local	6.2009	13.8	17.37
Nagercoil Local	7.4743	13.2	17.56
C.D. (P=0.05)	0.0947	0.5887	0.7857

into four, three and two categories, respectively. Similar classification were made for varietal identification vicia sativis (Gil and Cubro, 1993). In nutshell, the bhendi seeds could be classified into three groups *viz.*, (i) old sized (Nagercoil and Arka ananmica), (ii) small sized (Kudiatham local, Pusa makhmali, CO1 and MDU1) and (iii) medium sized (other types) (Table 1). The percentage contribution of embryo is the highest for Pusa makhmali and Arka anamica and the lowest in Nagercoil and Kudiatham local. The percentage contribution of seed coat is lowest in Pusa makhmali, Arka anamica, Pusa sawani and CO2 and the highest in Nagercoil local type (Table 1). Based on the percent contribution of embryo and seed coat the varieties were grouped into five and four groups, respectively. Based on the seed coat/embryo ratio the varieties were grouped unto three viz., (i) low 0.96 -1.01 (Arka anamica, Pusa sawani, Pusa makhmali, MDU1 and CO2), (ii) high 1.08 - 1.1 (Nagercoil and Kudiatham local types) and (iii) medium 1.02 - 1.07 (other varieties) Table 2).

Based on the varieties observed for 100-seed weight, five classes were obtained viz., very small (<6.298 g : CO1, Pusa makhmali, Kudiatham local, MDU1 and CO3), small (6.32 - 6.42g : CO2 and Pusa sawani), medium (6.52-6.619 g : AE 180), large (6.625-6.72 g : Parbhani kranti and Arka anamica) and bold (>6.9 g : Punjab padmini and Nagercoil local) Table 2). Such classification based on seed weight was made by Chandgiram *et al.* (1988). Agarwal and Pawar (1990) and Jawaharlal (1994) in various crops.

Based on the oil and protein content of seeds, the genotypes were grouped into four classes. Oil content grouped into 13.2-14.2% (Pusa sawani, Punjab padmini, Nagercoil and Kudiatham local), 15.1-16.1% (CO2, CO3, AE180 and MDU1), 16.4-17.4% (CO1, Arka anamica, Parbhani kranti) and > 17.5% (Pusa makhmali). Protein content grouped into 17.37 - 18.15% (CO3, Parbhani kranti, Pusa sawani, Arka anamica, Nagercoil and Kudiatham local), 18.16-19.04% (MDU1 and CO2), 19.15-19.94% (CO1 and AE180) and >20.5% (Pusa makhmali and Parbhani kranti) Table 2). Similar variations among the genotypes were reported by Sujatha *et al.* (1986) and Berry *et al.* (1988) in bhendi. Based on the results obtained, it was possible to construct to flow charts based on seed morphological characters (Flowchart -1) and chemical composition of seeds (Flowchart 2). It was possible to identify each and every genotype from the above flowcharts.

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INFLUENCE OF HALOGEN TREATMENTS ON VIABILITY OF AGED COTTON SEEDS

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ABSTRACT

Seeds of seven *Gossypium hirsutum* genotypes, stored under ambient condition for one, two, three and four years were treated with chlorine (5g kg^{-1}) and iodine (3g kg^{-1}) halogen formulations. The treated seeds were accelerated aged at 40°C and 95% RH for 48 hrs. The estimations of seed quality and predictions of seed storability revealed that seeds treated with chlorine (@ 5g kg^{-1}) and iodine (@ 3g kg^{-1}) formulation extended the viability and vigour potential and reduced the pathogenic seed infection. The improvement in viability was 6.0 and 7.0%, respectively due to chlorine and iodine treatments over untreated seeds. The rate of improvement in viability decreased with increasing age of seeds at the time of seed treatment. The mean vigour index over genotypes and seed treatments was 36, 540, 1283 and 1560, respectively in one to four years aged seeds. In all the seed lots, improvements of vigour due to chlorine and iodine treatments were on par with a significant superiority over control. The electrical conductivity and leaching of sugars were noticed less in seeds treated with chlorine and iodine. The dehydrogenase enzyme activity was 2.64, 2.26, 2.01 and 1.54, respectively from one to four years aged seeds. This was found to increase due to iodine (2.20) and chlorine (2.16) treatment than in the untreated seeds (1.98). There were significant reductions in percentage of infected seed, due to chlorine (31.4%) and iodine (30.7%) treatments than in the untreated (44.4). Since, halogen formulations have multi benefits such as improvement in viability and vigour, prevention of pathogenic seed infection and further extension of seed storability, treatment of cotton seeds using the vapour form of chlorine and iodine may be recommended.

Key words : Cotton seed, seed storage, chlorine, iodine, accelerated ageing.

Seed is a biological entity and living miniature plant. Soon after the attainment of physiological maturity in the mother plant ageing of seeds starts and continues till the death of seed. The process of ageing is continuous and hence, cannot be stopped once for all. However, this is accelerated while the seeds are stored for longer period. The ageing process occurring during storage reduces seed viability, vigour and seed health and ultimately making the seed unused for planting. In this process, the loss of cell membrane function is one of the basic reasons for senescence in biological systems (Tappel, 1973). Basu (1976) proposed the concept of free radical production during lipid per oxidation, as the basic cause for seed deterioration, which in turn results in loss of vigour and poor germination in stored seeds. During storage, cotton seeds deteriorates at a faster rate and produce weaker seedlings when they are planted.

Halogens have been suggested as a potent remedy to the injuries caused due to ageing (Dharmalingam and Basu, 1978) and hence attempts have been made in the present investigation to find out its efficacy under accelerated condition with differentially aged seed lots from seven cotton genotypes.

MATERIALS AND METHODS

The fuzzy cotton seeds of seven *Gossypium hirsutum* genotypes *viz.*, 70 E, Bikaneri Narma (BN), AC.738, PIL.43, PIL.8, T.7 and M.12 were stored under ambient conditions without seed treatments for one, two, three and four years. The stored seeds were dry dressed with a mixture of calcium oxychloride and calcium carbonate (3:1), incubated for 48 hours @ 5 g kg^{-1} and iodine vapours impregnated in the calcium carbonate @ 3 g kg^{-1} to serve as a source of chlorine and iodine, respectively. The halogenated seeds were packed in airtight containers and kept for seven days under ambient condition along with untreated seeds. After seven days, seeds were repacked in perforated paper bags and placed in an incubator maintaining the temperature of 40 +/- 1°C and relative humidity of 95+/- 2% for 48 hours along with their respective control. After two days of incubation, they were exposed to room temperature and the following quality assessments were done. The seed viability was assessed by placing four replications of 100 seeds each in sand medium (ISTA, 1999). The normal seedlings were counted after a period of 12 days and expressed in germination percentage. The seedling vigour index was calculated by multiplying germination percentage and seedling length as per Abdul-Baki and Anderson (1973). The electrical conductivity of seed leachate (Presley, 1958), reducing sugar (Somogyi, 1952) and dehydrogenase enzyme activity (Kittock and Law, 1968) was estimated. The seed storage fungi were estimated using blotter technique (ISTA, 1999). The data thus recorded for all the above parameters were analyzed statistically for test of significance (Gomez and Gomez, 1984). The data expressed in percentages were transformed into its corresponding arcsine values before analysis, wherever necessary.

RESULTS AND DISCUSSION

The viability of aged seeds showed significant differences in all genotypes due to seed treatments. It was highest in one year aged seeds (70%) and least in four year aged seeds (2%). Among the treatments, chlorine (44.0%) and iodine (45.0%) treated seeds excelled the untreated seeds (38%). An improvement in germination from one year to four year naturally aged seeds was noticed due to seed treatments. The viability improvement due to chlorine treatment was 2.0, 7.0, 7.0 and 8.0%, respectively in one, two, three and four year aged seeds which was 1.0, 11.0, 7.0 and 8.0%, respectively due to iodine treatments. However, the rate improvement in germination after accelerated ageing decreased with increasing age of seeds (Table 1). The progressive improvement in germination due to chlorination was reported by Rudrapal and Basu (1981). The responses of genotypes for seed treatments were also noticed. The genotypes were highly responsive when the seeds were less aged and with the advancement of natural ageing they showed less response as evidenced in four year aged seeds, in which the seeds of genotypes 70 E, Bikaneri Narma, AC 738 and M.12 were responsive. It was noted that these treatments imparted resistance to overcome the stress due to accelerated ageing and controlled deterioration significantly, irrespective of the genotypes. Under accelerated aged condition, the rate of seed deterioration was maximum in untreated seeds especially with genotypes having poor storage potential.

The mean vigour index over genotypes and seed treatments was 36, 540, 1283 and 1560, respectively in one to four years aged seeds (Table 2). In all these seed lots, improvements of vigour due to chlorine and iodine treatments were on par with a significant superiority over control. This observation is in consonance with similar studies of Madanagopal and Dharmaligam (1993) in gingelly seeds. It may be noted that the vapour forms of chlorine and iodine impregnated in the seed improved the viability and vigour and further extended the storability as predicted through accelerated ageing. The possible reason might be the counter of free radical formation and lipid per oxidation reactions along with increased membrane stability. Stabilization of unsaturated fatty acid components of lipoprotein moiety of cellular membranes and making them less susceptible to further oxidation have been suggested (Basu and Rudrapal, 1980). In the present investigation, the electrical conductivity and leaching of sugars were recorded less in seeds treated with chlorine and iodine, however it was higher in untreated seeds. The electrical conductivity and percentage loss of sugars are negatively correlated with seed quality (Doijode, 1986). Weakening of cell membrane has been ascribed to be the cause for leaching of metabolites and electrolytes through the semi permeable membrane into the imbibing medium. The halogens by counteracting the free radical propagation chain reaction maintained and/or improved the membrane integrity and thereby minimized the leakage of electrolytes from the cell. In the present study, seed

Table 1. Effect of halogen treatments on germination (%) of cotton seeds after accelerated ageing

Genotypes/	Four year aged				Three year aged				Two year aged				One year aged				Grand
Treatments	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	mean
70E	5.0	11.0	10.0	9.0	11.0	16.0	25.0	17.0	65.0	72.0	69.0	69.0	61.0	65.0	67.0	64.0	40.0
	(12.9)	(19.4)	(18.3)	(16.9)	(19.2)	(23.2)	(30.0)	(24.1)	(53.8)	(58.1)	(56.2)	(56.0)	(51.4)	(53.7)	(54.9)	(53.3)	(37.6)
Bikaneri	0	6.0	2.0	3.0	8.0	11.0	16.0	12.0	47.0	69.0	60.0	59.0	68.0	69.0	70.0	69.0	35.0
Narma	(0.0)	(14.0)	(8.1)	(7.4)	(16.3)	(18.9)	(23.4)	(19.5)	(43.3)	(55.9)	(50.8)	(50.0)	(55.6)	(56.2)	(57.1)	(56.3)	(33.3)
AC.738	4.0	6.0	5.0	5.0	29.0	45.0	38.0	37.0	55.0	59.0	67.0	60.0	56.0	65.0	63.0	61.0	41.0
	(11.5)	(10.4)	(8.7)	(10.2)	(32.6)	(42.1)	(38.0)	(37.6)	(47.9)	(50.2)	(55.0)	(51.0)	(48.5)	(53.7)	(52.6)	(51.6)	(37.6)
PIL.43	0	0	0	0	21.0	24.0	43.0	29.0	61.0	61.0	68.0	63.0	60.0	78.0	78.0	72.0	41.0
	(0.0)	(0.0)	(0.0)	(0.0)	(27.3)	(29.3)	(41.0)	(32.5)	(51.4)	(51.4)	(55.6)	(52.8)	(50.8)	(62.7)	(62.1)	(58.3)	(35.9)
PIL.8	0	0	0	0	28.0	39.0	41.0	36.0	61.0	72.0	63.0	65.0	65.0	72.0	74.0	70.0	43.0
	(0.0)	(0.0)	(0.0)	(0.0)	(31.9)	(38.6)	(39.8)	(36.8)	(51.4)	(58.2)	(52.6)	(54.0)	(53.8)	(58.1)	(59.3)	(57.1)	(37.0)
T.7	0	0	0	0	30.0	38.0	40.0	36.0	60.0	63.0	61.0	61.0	60.0	68.0	72.0	67.0	41.0
	(0.0)	(0.0)	(0.0)	(0.0)	(33.2)	(38.0)	(39.2)	(36.8)	(50.8)	(52.6)	(51.4)	(51.7)	(50.8)	(55.7)	(58.3)	(54.9)	(35.8)
M.12	0	7.0	0	2.0	63.0	64.0	63.0	63.0	65.0	67.0	80.0	71.0	81.0	89.0	81.0	84.0	55.0
	(0.0)	(15.3)	(0.0)	(5.1)	(52.6)	(53.2)	(52.6)	(52.8)	(53.8)	(55.0)	(64.2)	(57.6)	(64.2)	(70.7)	(64.5)	(66.5)	(45.5)
Mean	1.0	4.0	2.0	2.0	27.0	34.0	38.0	33.0	59.0	66.0	66.0	64.0	64.0	72.0	72.0	70.0	42.0
	(3.5)	(8.4)	(5.0)	(5.6)	(30.4)	(34.8)	(37.7)	(34.3)	(50.3)	(54.5)	(54.2)	(53.3)	(53.6)	(58.7)	(58.4)	(56.9)	(37.5)
Grand mean	Control	Chlorine	Iodine														
	38.0	44.0	45.0														
	(34.5)	(39.1)	(38.8)														
	A	G	T	AxG	GxT	AxT											
SEd	1.19	1.57	1.03	3.14	2.72	2.06											
CD (P=0.05)	2.36	3.12	2.04	6.25	5.41	4.09											

G- Genotypes ; A - Age of the seeds ; T - Treatments

(Figures in the parentheses indicate arcsine-transformed values)

Table 2. Effect of halogen treatments on vigour index of seedlings from accelerated aged cotton seeds

Genotypes/	Four year aged				Three year aged				Two year aged				One year aged				Grand
Treatments	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	mean
70 E	78	134	140	117	163	210	375	249	1203	1620	1213	1345	1164	1710	1459	1444	789
BN	0	69	25	31	98	203	213	171	692	1157	1128	993	1636	1912	1804	1783	745
AC.738	49	158	0	69	376	663	496	512	1145	1292	1293	1243	1377	1555	1602	1511	834
PIL.43	0	0	0	0	370	356	690	472	1317	1325	1491	1378	1368	1561	1444	1458	827
PIL.8	0	0	0	0	419	662	815	632	1241	1423	1520	1395	1576	1606	1745	1642	917
T.7	0	0	0	0	445	589	574	536	1251	1430	1285	1322	1321	1921	1770	1671	882
M.12	0	95	0	32	1114	1337	1169	1207	1227	1283	1413	1307	1284	1375	1574	1417	989
Mean	18	65	24	36	426	574	619	540	1154	1361	1335	1283	1389	1663	1628	1560	855

Grand mean	Control	Chlorine	Iodine			
	747	916	902			
	A	G	T	AxG	GxT	AxT
SEd	32.4	42.8	28.0	85.6	74.1	56.0
CD (P=0.05)	64.4	85.1	55.7	170.3	147.4	NS

G - Genotypes ; A - Age of the seeds ; T - Treatments

deterioration was found correlated with electrical conductance and reducing sugars of seed leachate and hence, these could be considered as an index to test the quality of cotton seeds (Malik *et al.* 1994). Irrespective of treatments and age of seed, between genotypes the least value of electrical conductivity 0.359 dS m^{-1} (Table 3) and sugar 0.007 (Table 4) was recorded in Bikaneri Narma and was highest in T.7 seeds.

The dehydrogenase enzyme activity was in the decreasing order and it was 2.64, 2.26, 2.01 and 1.54, respectively from one to four years aged seeds. The enzyme activity was found to increase due to iodine (2.20) and chlorine (2.16) treatment than in the untreated seeds (1.98) (Table 5). In cotton seeds, dehydrogenase activity was reduced due to ageing (Jeyanthi Pchammal, 1996). The loss of energy production during germination might be the reason for reduced dehydrogenase activity (Abdul-Baki and Anderson, 1973) and this was evident in the present study.

The pathogenic infection of seed was higher in four year aged seeds (55.6%) and least in one year old seeds (17.3%). There were significant reductions in percentage of infected seed due to chlorine (31.4%) and iodine (30.7%) treatments than in the untreated (44.4%) (Table 6). This might be due to the antifungal property of chlorine (Bayette *et al.* 1993), which has the ability in controlling a wide number of fungi and bacteria causing post harvest decay. Rudrapal and Nakamura (1988) reported that halogen treatments significantly slow down the deterioration of eggplant seeds under accelerated ageing condition.

In conclusion, since halogen formulations have multi benefits such as improvement in viability and vigour, leaching of sugars and reduction in electrical conductivity of seed leach ate, prevention of pathogenic seed infection and further extension of seed storability, treatment of cotton seeds using the vapour form of chlorine and iodine may be recommended especially for seed lots intended for long-term storage.

Table 3. Effect of halogen treatments on electrical conductivity of seed leachate (dS m^{-1}) of accelerated aged cotton seeds

Genotypes/	Four year aged				Three year aged				Two year aged				One year aged				Grand
Treatments	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	mean
70E	0.472	0.413	0.391	0.425	0.437	0.423	0.370	0.410	0.457	0.424	0.490	0.457	0.300	0.291	0.212	0.267	0.390
BN	0.461	0.247	0.245	0.317	0.384	0.465	0.384	0.411	0.379	0.376	0.317	0.357	0.373	0.311	0.364	0.349	0.359
AC.738	0.533	0.343	0.439	0.438	0.513	0.445	0.473	0.477	0.502	0.456	0.466	0.475	0.461	0.352	0.326	0.379	0.442
PIL.43	0.489	0.347	0.301	0.379	0.469	0.358	0.450	0.425	0.615	0.615	0.586	0.606	0.826	0.681	0.696	0.734	0.536
PIL.8	0.487	0.293	0.442	0.407	0.498	0.477	0.465	0.480	0.437	0.336	0.363	0.378	0.488	0.502	0.484	0.491	0.439
T.7	0.813	0.511	0.592	0.638	0.920	0.830	0.806	0.852	0.665	0.562	0.604	0.610	0.592	0.549	0.516	0.552	0.663
M.12	0.599	0478	0.367	0.481	0.424	0.289	0.300	0.337	0.477	0.448	0.441	0.455	0.358	0.272	0.299	0.309	0.396
Mean	0.550	0.376	0.397	0.441	0.520	0.469	0.464	0.485	0.504	0.459	0.467	0.477	0.485	0.422	0.414	0.440	0.461
Grand mean	Control	Chlorine	Iodine														
	0.515	0.432	0.435														
	A	G	T	A X G	GxT	AXT											
SEd	0.010	0.104	0.009	0.028	0.024	0.018											
CD (P=0.05)	0.021	0.028	0.018	0.056	NS	0.037											

G - Genotypes; A - Age of the seeds; T - Treatments

Table 4. Effect of halogen treatments on reducing sugar content (mg $seed^{-1}$) of seed leachate of accelerated aged cotton seeds

Genotypes/	Four year aged				Three year aged				Two year aged				One year aged				Grand
Treatments	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	mean
70E	0.011	0.006	0.008	0.008	0.008	0.004	0.004	0.005	0.033	0.022	0.020	0.025	0.006	0.003	0.002	0.004	0.010
BN	0.001	0.002	0.002	0.005	0.010	0.003	0.002	0.005	0.013	0.009	0.008	0.010	0.010	0.004	0.007	0.007	0.007
AC.738	0.013	0.008	0.005	0.008	0.027	0.007	0.009	0.014	0.014	0.016	0.011	0.013	0.008	0.006	0.006	0.006	0.010
PIL.43	0.021	0.007	0.017	0.015	0.011	0.006	0.010	0.009	0.021	0.020	0.013	0.018	0.026	0.018	0.008	0.017	0.015
PIL.8	0.020	0.013	0.008	0.014	0.005	0.004	0.010	0.004	0.009	0.006	0.006	0.007	0.021	0.013	0.020	0.018	0.010
T.7	0.024	0.013	0.018	0.018	0.018	0.014	0.011	0.014	0.011	0.009	0.010	0.010	0.013	0.012	0.013	0.013	0.014
M.12	0.012	0.006	0.002	0.006	0.003	0.003	0.002	0.002	0.014	0.012	0.014	0.013	0.004	0.004	0.004	0.004	0.006
Mean	0.016	0.008	0.008	0.011	0.012	0.006	0.006	0.008	0.016	0.013	0.012	0.014	0.012	0.008	0.008	0.010	0.010
Grand mean	Control	Chlorine	Iodine														
	0.014	0.009	0.009														
	A	G	T	AxG	GxT	AxT											
SEd	0.0009	0.0011	0.0007	0.0022	0.0020	0.0015											
CD (P=0.05)	0.0017	0.0012	0.0015	0.0045	NS	NS											

G - Genotypes; A - Age of the seeds; T - Treatments

Table 5. Effect of halogen treatments on dehydrogeanase activity in accelerated aged cotton seeds

Genotypes/	Four year aged				Three year aged				Two year aged				One year aged				Grand
Treatments	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	mean
70E	0.85	0.91	0.93	0.89	1.12	1.16	1.21	1.16	2.28	2.50	2.57	2.45	2.17	2.35	2.31	2.27	1.70
BN	1.12	1.81	1.36	1.43	1.85	1.96	1.21	1.16	2.01	2.42	2.19	2.21	2.93	2.95	2.98	2.95	2.13
AC.738	1.25	1.56	1.51	1.44	1.97	2.13	2.49	2.20	1.83	1.81	1.92	1.85	1.83	2.10	2.80	2.24	1.93
PIL.43	1.12	1.44	1.37	1.31	1.70	1.76	1.80	1.75	2.27	2.91	2.80	2.60	2.44	2.50	2.55	2.50	2.06
PIL.8	1.68	1.75	1.88	1.77	2.69	2.71	2.74	2.72	2.76	2.78	2.79	2.77	2.94	2.97	2.99	2.96	2.56
T.7	1.95	2.06	2.03	2.01	1.90	2.04	2.07	2.00	2.20	2.30	2.36	2.28	2.74	2.94	2.95	2.88	2.29
M.12	1.88	1.88	1.92	1.89	2.16	2.40	2.40	2.32	1.16	1.79	1.80	1.59	2.55	2.66	2.85	2.69	2.11
Mean	1.41	1.63	1.57	1.54	1.91	2.02	2.09	2.01	2.07	2.36	2.35	2.26	2.51	2.64	2.77	2.64	2.11
Grand mean	Control	Chlorine	Iodine														
	1.98	2.16	2.20														
	A	G	T	AxG	GxT	AxT											
SEd	0.03	0.04	0.02	0.07	0.06	0.05											
CD (P=0.05)	0.06	0.07	0.05	0.15	0.13	0.10											

G - Genotypes; A - Age of the seeds; T - Treatments

Table 6. Effect of halogen treatments on pathogen infection (%) of accelerated aged cotton seeds

Genotypes/	Four year aged				Three year aged				Two year aged				One year aged				Grand
Treatments	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	Control	Chlorine	Iodine	Mean	mean
70E	57.5	52.5	55.0	55.0	37.5	20.0	30.0	29.2	27.5	17.5	22.5	22.5	25.0	20.0	22.5	22.5	32.3
BN	60.0	50.0	45.0	51.7	50.0	45.0	25.0	38.3	40.0	30.0	25.0	31.7	35.0	15.0	12.5	20.8	35.6
AC.738	60.0	20.0	42.5	40.8	37.5	35.0	32.5	35.0	30.0	27.5	22.5	26.7	20.0	7.5	15.0	14.2	29.2
PIL.43	67.5	67.5	45.0	60.0	37.5	35.0	22.5	31.7	32.5	30.0	20.0	27.5	20.0	17.5	12.5	16.7	34.0
PIL.8	92.5	52.5	62.5	69.2	52.5	52.5	42.0	49.0	57.5	17.5	30.0	35.0	30.0	10.0	5.0	15.0	42.0
T.7	85.0	57.5	62.5	68.3	67.5	62.5	50.0	60.0	47.5	35.0	32.5	38.3	20.0	12.5	10.0	14.2	45.2
M.12	45.0	42.5	45.0	44.1	45.0	15.0	25.0	28.0	37.5	25.0	30.0	30.8	25.0	12.5	15.0	17.5	30.2
Mean	66.8	48.9	51.1	55.6	45.8	37.1	32.4	38.8	38.9	26.1	26.1	30.3	25.0	13.6	13.2	17.3	35.5
Grand Mean	Control	Chlorine	Iodine														
	44.4	31.4	30.7														
	A	G	T	AxG	GxT	AxT											
SEd	1.72	2.28	1.49	4.56	3.95	2.98											
CD (P=0.05)	3.43	4.53	2.97	9.06	7.85	NS											

G - Genotypes; A - Age of the seeds; T - Treatments

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EFFECT OF SPLIT APPLICATION AND LEVELS OF K ON YEILD OF MAIZE

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ABSTRACT

An investigation was conducted to evaluate the yield response of maize and its yield attributes viz, cob length, cob girth, per cent of double cobs, cob filling percentage, 100 grain weight to different levels of K to maize crop. The effect of levels of K as well as split application on nutrient uptake was also studied. The study revealed that application of 200 kg of K/ha in three split application resulted in maximum grain yield. The yield parameters also improved due to the application of 200 kg of K/ ha in thre splits. Uptake of nutrients viz., N, P, K were also maximum for the application of 200 kg of K/ha.

Key words : Maize, yield, yield attributes, nutrient uptake.

In Tamil Nadu, the area under maize is increasing due to escalation in broiler feed production and various food processing inductries. Maize consumes around 175 kg/ha of K (LTFE, Annual Report, 2002) and the application of K is far below the uptake, there is an urgent need for the replacement of K that is removed from the soil. Also, as such the existing recommendation towards K fertilization to maize crop is also far below the uptake i.e. 50 kg K_2O/ ha. Hence there is a need to fix up the K dose to be applied for maize, which consumes K to a tune of 175 kg/ha.

Hence an experiment was conducted to study the effect of levels and split application of K on yield of maize.

MATERIALS AND METHODS

A field experiment was conducted in a sandy loam soil (Alfisols) with eight treatments replicated thrice in a split-plot design and mazie as the test crop. The treatment consisted of M_1 and M_2 being main plots viz., 2 splits and 3 applications of K. The sub plot treatments were 50, 100, 150 and 200 kg of K_2O/ha as S_1, S_2, S_3 and S_4 repectively. The soil was neutral in pH (8.15), and the EC was 0.27 dSm^{-1}. The experimental soil was low in N and K (210, 70 kg/ha, respectively and medium in P (11.5 kg/h) with regard to their available nutrient status.

RESULTS AND DISCUSSION

Yield

The grain yield increased with 50 kg K_2O to 200 kg K_2O/ha (Table 1). Application of 50 per cent higher over recommended level of N and K (180 kg N and 60 kg K_2O/ha) recorded significantly higher growth and yield parameters. Increased grain yield higher doses of K_2O were also reported in like rice and sorghum (Singh *et al.*, 2003). Similar results were also reported by Zhu-Huaming *et al.* (1998).

Yield parameters

The M_2 was on par with M_1 in the length of the cob. Application of 150 kg of K_2O/ha (S_3) recorded maximum cob length which was on par with application of 200 kg of K_2O/ha. The length of the cob due to various treatments of K ranged from 17.04 cm to 18.02 cm. A similar treand was noticed in case of cob girth also. The girth of the cub due to various treatments of K ranged from 12.96 cm to 14.26 cm. In case of double cobs percentage also a similar trend was notice with regard to split application. Regarding the levels of K, application of 100 kg of K_2O/ha (S_2) was on par with application of 150 kg K_2O/ha (S_3). No increasing trend in the double cobs percentage

Table 1. Grain and straw yield (t/ha), N, P and K uptake (kg/ha) as influenced by K fertilization

Treatment		Straw yield	Grain yield	N	P	K
M1	S_1	10.59	4.02	139.47	27.06	67.62
	S_2	11.00	4.08	149.71	28.93	95.83
	S_3	11.17	4.29	161.76	29.79	106.58
	S_4	12.92	4.72	205.67	33.03	128.33
Mean (M1)		11.42	4.28	164.15	29.70	99.59
M2	S_1	11.54	4.02	143.25	23.09	71.14
	S_2	11.08	4.09	152.90	27.94	93.99
	S_3	11.25	4.36	160.23	32.27	106.74
	S_4	11.54	4.81	176.95	33.34	117.18
Mean (M2)		11.36	4.32	158.33	29.26	97.26
Mean (Levels)	S_1	11.06	4.02	141.36	26.01	69.38
	S_2	11.04	4.09	151.30	27.50	94.91
	S_3	11.21	4.33	160.99	31.03	106.66
	S_4	12.23	4.76	191.31	33.38	122.76
SEd ±	M	0.112	0.069	1.138	0.766	0.838
	S	0.187	0.043	2.349	0.948	2.176
	MXS	0.373	0.087	4.697	1.897	4.352
	SXM	0.342	0.102	4.224	1.812	3.861
CD at 5%	M	0.48	0.30	4.90	3.30	3.61
	S	0.41	0.10	5.12	2.07	4.74
	MXS	0.81	0.19	10.23	4.13	9.48
	SXM	0.82	0.32	9.86	4.64	8.80

with the increase in K levels was observed. The M_1 was on par with M_2 in the cob filling percentage. S_4 was on par with S_3 in the cob filling percentage. Application of 200 kg of K_2O/ha (S_4) and 150 kg of K_2O/ha (S_3) had some effect in the cob filling percentage (85%). The cob filling percentage due to various treatments of K ranged from 75 to 85 per cent. The M_2 was significant in the 100 grains weight than M_1. Application of 100 kg of K_2O/ha (S_2) was on par with application of 200 kg of K_2O/ha (S_4). Among all levels S_2 (100 kg of K_2O/ha) showed increment in the weight of the grains.

Though the number of double cobs per plant and length of the cob did not proportionately increase with increasing level of K_2O, after 150 kg/ha, the other prameters showed a positive effect with regared to K_2O levels. Number of split applications did not have effect over these yield parameters.

Similar increase in the number of cobs per plot, number of grains/cob and increase in grain weight with increasing levels upto 60 kg K_2O/ha, were earlier reported by Singh *et al.* (2003) in maize. The increase in the yield parameters for the increase in K dosage can be attributed to the ability of K on sugar/starch translocation. Potassium is known to play a vital role in photosynthesis (Huber, 1985), translocation of photosynthates (Demming and Gimmler, 1983). A significant improvement in yield parameters like number of cobs per plant and cob length through higher K application were earlier reported by Kalpana and Krishnarajan (2002) in baby corn.

Uptake of N, P and K

The mean N uptake ranged from 141kg/ha to 191 kg/ha with the application of recommerded dosage of nitrogenous fertilier (135 kg/ha). The increased levels of K additions enhanced the nitrogen uptake gradually (Table 1). This clearly proves the N and K interaction.

Application of K in three splits enhanced the N uptake rather than applying K in the two splits. Uptake of N with 3 splits of K was greater than that with 2 splits (Singh and Verma, 2001).

The P uptake due to various treatments ranged from 26 to 33 kg/ha. P uptake and was maximum for 200 kg of K_2O/ha application. The better root development would have enhanced the P uptake of the crop. Addition of K at different levels desirably influencing the root yield have been reported earlier by Natrajan and Renuka Devi (2003) in sorghum.

The potassium uptake of the crop ranged from 69 kg to 122 kg/ha. The increasing levels of K application resulted in increased quantities of K uptake from 50 kg to 200 kg/ha. Varadarajan (1976) reported that the uptake of K by grain, straw and total dry matter increased with the increase in K levels. Meena *et al.* (2002), reported significantly higher NPK uptake by hybrid rice due to K fertilization upto the level of 75 kg K_2O/ha. Similar increase in NPK uptake due to K fertilization with splits were also reported by Thakur *et al.* (1999).

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PHENOTYPIC STABILITY IN BLACKGRAM (*VIGNA MUNGO* (L.) HEPPER)

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ABSTRACT

Eleven genotypes of blackgram were evaluated at four environments during rabi 2001-04 to study the nature and magnitude of genotype x environment interaction. Highly significant differences were observed among the genotypes and environments for the component characters, days to 50% flowering, days to maturity, plant height, pods per plants, seed per pod and also seed yield. Highly significant GXE interactions were also observed for most of the characters. Genotypes LBG 709, LBG 693, LBG 712 and MBG 207 were found to be the most desirable genotypes for high seed yield, pods per plant, earliness, seeds per pod and seed weight and hence these genotypes could be used in future breeding programmes of urbean.

Key words : Blackgram, phenotypic stability, yield, yield components, *Vigna mungo* L. Hepper.

Blackgram (*Vigna mungo* L. Hepper) is one of the most important pulse crops grown in South India. It is one of the ideal crops which fits in various cropping systems and most suitable for growing during early rabi, rabi as well as under rice fallows capitalizing the residual soil moisture because of vailability of short-duration, drought-resistant, photo and thermo-insensitive varieties. However, these varieties shows great fluctuation in yield due to sensitivity to different growing seasons and conditions. The genotypes showing least G x E interaction are considered as most desirable. Hence, it is necessary to screen and identify genotypes stable for wide cultivation, which will perform more or less uniformly under different environmental conditions. Therefore, data on grain yield and its components on 11 genotypes of blackgram were subjected to stability analysis to obtain information on genoype x environment interaction and to identify most stable genotype.

MATERIALS AND METHODS

Eleven genotypes of blackgram were sown in a randomized block design with three replications at Agricultural Research Station, Madhira during rabi 2000-01, 2001-02, 2002-03 and 2003-04. The row to row and plant to plant distance was 30x10 cm, respectively. Recommended package of practices were followed to raise good crop. Data were recorded on ten randomly selected plants in each replication for days to 50% flowering, days to maturity, plant height (cm), pods per plant, clusters per plant, seeds per pod, 100-seed weight (g) and seed yield per plot.

Data were analyzed statistically for each year and for pooled data. The data were further analyzed statistically for three stability parameters viz., mean (Xi), regression coefficient (bi) and deviation from regression (Sdi^2) as per the model of Eberhart and Russel (1966).

RESULTS AND DISCUSSION

Environment (year) - wise analysis revealed significant differences among genotypes under each environment. The pooled analysis of variance (Table 1) showed that the varieties differed significantly among themselves for component characters like days to 50% flowering, days to maturity, plant height and seed weight.

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Table 1. Anova for stability analysis for 8 characters in blackgram

Source	df	Days to 50% flowering	Days to maturity	Plant height (cm)	Cluster per plant	Pods per plant	Seeds per pod	100 seeds weight (g)	Grain yield (kg /ha)
Varieties	10	31.33**	35.01****	52.08***	3.64	9.65	0.56	0.41***	8142.8
Envrionment	3	2.05	38.56***	333.06***	7.66*	37.62**	0.278	0.112	370789.5***
Var x Ern	30	5.62	6.44	16.99	2.40	9.66	0.27	0.05	11443.5
Env + (Van x Env)	33	5.29	9.36	45.73	2.88	12.20	0.27	0.06	44111.3***
Env (Linear)	1	6.13	115.7***	999.17***	22.98*	112.87***	0.53	0.37**	112269.0***
Var x Enrv (lin)	10	4.67	10.88	23.30	1.72	11.80	0.27	0.083	17609.3
Pooled deviation	22	5.54***	3.83*	125.9**	2.49***	7.81	0.25	0.04	7600.6*
Polled error	80	1.71	2.08	3.87	0.56	7.72	0.56	0.06	4009.8

Variance due to environments were highly significant for grain yield, pods per plant, clusters per plant, plant height and days to maturity. Similarly, high magnitude of environment (linear) effet in comparison to variety x environment (linear) ineraction was recorded which may be responsible for high adaptation in relation to these traits like grain yield, seed weight, pods per plant, clusters per plant and days to maturity. Variety x environment (linear) variance was significant for grain yield and maturity when tested against coresponding pooled error indicating that these traits could be predicted over environments. Chakraborty and Borua (1997) also observed significant interaction for phenological traits like flowering and maturity. Variance for pooled GXE interaction was highly significant for grain yield, clusters per plant, plant height, days to maturity and days to 50% flowering, which indicated that the variation of the genotypes for these traits over different environments was caused by unpredictable factors (Nizam and Patel, 1989; Singh *et al.*, 1995).

The values of environment indices (Table 2) were negative for days to 50% flowering (E_1 and E_4) day to maturity in (E_1 E_3 & E_4) plant height (E_1 and E_2), clusters per plant (E_2), pods per plant (E_2), seeds per pod (E_1 & E_4), 100 -seed weight (E_1 & E_2) and grain yield (E_2 and E_4) indicating that these environments were poor for the manifestation of these traits.

A genotype is considered to be stable in performance if it has high mean performance (Xi), unit regression coefficient (b=1) and least deviation from regression (S^2di) according to Eberhart and Russel (1966). Three stability parameters *viz.*, mean (Xi), linear sensitivity coefficient (bi) and non-linear sensitivity coefficient (S^2di) are given in Table 3. Three kinds of linear responses *viz.*, b<1, b=1 and b>i were observed. However, in certain genotypes, the bi values were negative for pods per plant, flowering, number of seeds pod and weight, which could be attributed to the inadequacy of the scale used for the analysis and for inherent behaviour of the genopype investigated. Similar

Table 2. Value of environmental indices for grain yield and component traits in blackgram

Environment	Days to 50% flowering	Days to maturity	Plant height (cm)	Clusters per plant	Pods per plant	Seeds per pod	100 seeds weight (g)	Grain yield (kg /ha)
E_1 (Rabi 2000-01)	-0.038	-1.841	-5.712	0.205	0.909	-0.167	-0.087	252.841
E_2 (Rabi 2001-02)	0.41	2.614	-3.439	-1.174	-2.697	0.136	-0.084	-43.063
E_3 (Rabi 2002-03)	0.205	-0.386	3.076	0.008	1.424	0.045	0.110	23.220
E_4 (Rabi 2003-04)	-.5.83	-0.386	3.076	0.462	0.364	-0.015	0.061	-186.553

Table 3. Mean (Xi), regression coefficient (bi) and deviation from regression (S^2di) for the characters in blackgram

S.No.	Genotypes	Days to 50% flowering			Days to maturity			Plant height			Clusters per plant		
		Xi	bi	S^2di	Xi	bi	S^2di	Xi	bi	S^2di	Xi	bi	S^2di
1	LBG 709	41.67	-1.30	-0.61	76.25	1.45	-0.96	36.75	1.33*	-2.49	6.17	0.96	2.96*
2	LBG 693	44.00	2.23	-1.18	77.75	1.45	-0.21	39.58	0.78	-0.78	7.33	0.50	2.16*
3	LBG 712	40.00	6.96	9.70**	75.50	1.06	-1.61	39.58	0.130	8.64	7.50	1.91	4.12***
4	LBG 714	39.75	0.45	3.53	83.75	0.18	0.98	40.67	1.49	4.08	8.00	1.12	0.12
5	LBG 716	35.50	-2.15	9.42**	78.00	2.70*	2.54	42.42	1.54	18.78*	6.83	0.76	0.88
6	LBG 719	38.50	-0.84	10.50**	80.00	-0.01	2.78	39.17	0.67	10.36*	7.67	0.52	1.48*
7	LBG 402	40.75	-3.25	10.64**	76.00	1.85	6.79*	37.83	0.44*	-1.84	7.25	-0.23	3.74**
8	LBG 17	43.50	3.35	-0.42	83.00	0.71	-1.86	39.25	0.86	17.22**	7.83	-0.29	3.50**
9	LBG 685	44.25	2.98	-0.89	81.75	-0.68*	4.72*	35.58	0.63*	-3.28	7.83	-0.29	3.50*
10	LBG 645	43.50	1.06	0.39	80.00	1.70	-0.47*	42.42	1.76	43.34***	8.67	2.55*	-0.03
11	MBG 207	43.50	1.55	0.03	75.75	0.17	5.01	29.58	0.22*	-282	9.83	2.13*	0.07
	General	**41.31**			**78.93**			**38.44**			**7.77**		

Table 4. Continued

S.No.	Genotypes	Days to 50% flowering			Days to maturity			Plant height			Clusters per plant		
		Xi	bi	S^2di	Xi	bi	S^2di	Xi	bi	S^2di	Xi	bi	S^2di
1	LBG 709	22.92	1.01	-5.11	5.42	3.42	-0.47	4.06	-1.24*	-0.05	883.33	1.2	5726.4
2	LBG 693	25.67	1.86	9.34	4.67	-1.87*	-0.31	4.78	2.85*	-0.04	929.2	1.37	233.6
3	LBG 712	24.42	3.53	23.11*	4.75	-1.56	-0.46	4.54	2.28	0.05	845.8	1.42	288.1
4	LBG 714	24.00	1.74	-3.31	4.67	1.04	-0.47	3.88	1.40	-0.06	785.8	0.58	4357.4
5	LBG 716	21.67	1.27	-0.53	4.25	-1.35	0.22	3.90	2.90*	0.04	866.67	1.35	719.9
6	LBG 719	25.58	0.47	-6.04	5.00	-1.66	-0.40	3.80	2.38*	-0.02	822.08	1.44	864.4
7	LBG 402	22.08	-0.18	-0.53	4.50	1.04*	0.03	4.05	-0.08*	-0.02	863.3	1.022	2816.5
8	LBG 17	22.42	0.33*	-7.64	4.67	1.45	-0.50	4.10	0.64	-0.06	826.7	0.23	11225.4*
9	LBG 685	21.75	-0.06	-1.77	7.75	3.84*	-0.43	4.10-	-0.16*	-0.05	790.0	0.47	-1401.6
10	LBG 645	21.67	0.69	-3.66	5.00	4.36	-0.02	4.55	1.86	-0.02	871.7	0.96	5128.4
11	MBG 207	24.50	0.35	4.08	5.50	2.28	0.52	3.98	-1.83	0.07	843.2	0.92	2852.4
	General	**23.30**			**4.83**			**4.16**			**843.2**		

observations were made by Gautam and Chaturvedi (1990). Genopypes with coefficients greater than 1.0 are adaptable to more favourable growing conditions, whereas those with co-efficient less than 1.0 are adopted to less favourable growing conditions. The regression coefficient close to 1.0 is considered to the most desirable, indicating that variety increases by an average amount as conditions improve. Smaller values of regression coefficient imply failure to take advantage of better conditions while larger values (b>1.0) simply suggest serious yield decline as condition worsen. The prediction of G x E interaction depends on relative magnitude of the linear and non-linear components and under the present situation the linear regression being predominant, assumed considerable practical significance. Significant deviations from linearity have arisen due to specific cultivar x environment interaction (Joppa *et al.*, 1971).

Earliness in flowering and maturity are preferred. The genotypes LBG 402, LBG 693, LBG 709, LBG 712, and MBG 207 exhibited greater stability over wide range of environments with early maturity, high mean seed yield, unit regression and least deviation from regression. Other genotypes were found significantly influenced by environmental fluctuation and hence unsuitable for certian environments. For the characters, clusters per plant, genotypes LBG 714, LBG 645 and MBG 207 performed well across the environments with hight mean while other genotypes were characterized as unstable genotypes. For pods per plant LBG 693, LBG 719 and MBG 207 appeared most stable over a series of fluctuating environments. With regard to seeds per pod LBG 709, LBG 645 and MBG 207 proved to be the more stable genotypes. For seed weight LBG 645, LBG 693 and LBG 712 should be preferred.

Genotypes LBG 709, LBG 693, LBG 712 and MBG 207 because of stable performances for earliness, pods per plant, seeds per pods and seed yield are recommended for cultivation on wider area.

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RESPONSE OF VARIOUS HIGH YIELDING WHEAT VARIETIES TO DIFFERENT NITROGEN LEVELS IN ALIGARH REGION OF UTTAR PRADESH

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ABSTRACT

A field experiment was conducted at Agriculture Research Farm of Ch. Charan Singh, Shiv Dan Singh (P.G.) College Iglas, Aligarh during *rabi* season of 2003-04. To find out the most suitable variety of wheat among newly evolved HYV'S for maximum grain production and fertilizer (N) response of wheat varieties. Wheat cultivar PBW-343 fertilized with 160 kg N/ha recorded highest yield grain, straw protein yield and nitrogen uptake from timely sown wheat crop.

Key words : Wheat, N levels, yield.

Nitrogen is most deficient element, especially in the course textural soils of Uttar Pradesh. Adequate supply of nitrogen to wheat is associated with efficient source to sink relationship of nitrogen source need to be standardized. Keeping this view the studies carried out to know the response of various hybrids wheat varieties to different levels of nitrogen in Aligarh region of Uttar Pradesh.

MATERIALS AND METHODS

The field experiment was conducted during winter 2003-04 at Research Farm of Ch. Charan Singh, Shiv Dan Sing (P.G.) College, Iglas, Aligarh. The soil of the experiment field was sandy loam in texture with low fertility in term of nitrogen, organic carbon, medium in phosphorous and rich in potassium. The soil was alkaline in nature having pH 7.5. The experiment comprising 12 treatment combinations with varieties HD-2687, PBW-343 and 2329 was in main plot and N levels 0, 80, 120 and 160 kg in sub plots.

The experiment was laid out in factorial randomized black design with three replications. Recommended half dose of nitrogen and full dose of phosphorus and potash were applied through drill in furrow 3-4 cm below the seed at sowing time. The remaining half dose of nitrogen through urea as per treatment was applied at 35 days after sowing. All the three varieties of wheat crop were sown on 19 November, 2003 and harvested on 4 April 2004.

RESULTS AND DISCUSSION

Effect of varieties

Among the various wheat cultivars, PBW-343 recorded the highest 1000-grain weight (41.01), while cultivars HD-2329 recorded the lowest 1000 -grain weight (31.83 g). The grain yield was highest with PBW-343 followed by HD-2687 and lowest (44.55 kg/ha) with 2329. Wheat cultivar PBW-343 recorded 5.71 and 12.23 % more yield over cultivar HD-2687 and HD-2329. Straw yield was not significantly affected due to varieties while cultivar PBW-343 recorded the highest (75.61 q/ha) straw yield. The increase in yield might be effected by greater and efficient translocation of photosynthates from source towards sink, ultimately improving the yield. This is in conformity to the results of Sardana *et al.* (2002).

Nitrogen content (%) and protein content (%) in wheat grain and in straw remained unaffected due to the varieties. Protein yield through wheat grain and straw yield were significantly higher with HD-2687 as compared to HD-2329 but remained at par with straw, it was significantly more with HD-2687 over other cultivars of wheat. Among the different cultivars of wheat HD-2329 was the poorest in uptake of

Table 1. 1000-grain weight, grain, straw yield, protein content in grain and straw, protein yield and nitrogen uptake as affected by varieties and levels of nitrogen in wheat

Treatment	1000-grain weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Protein content (%)		Protein production		Nitrogen content		Nitrogen uptake	
				Grain	Straw	Grain (kg/ha)	Straw (kg/ha)	Grain	Straw	Grain	Straw
Varie ties											
HD-2687	40.34	48.14	70.33	13.40	3.87	592.90	293.34	2.34	0.68	99.56	51.01
PBW-343	41.01	50.89	75.61	13.33	3.84	565.63	280.03	2.37	0.67	98.74	48.08
HD-2324	31.83	44.55	74.97	12.55	3.75	473.48	226.70	2.27	0.65	82.78	42.37
SEm ±	1.12	1.06	1.12	0.58	0.04	30.30	11.21	0.09	0.1	5.72	1.00
CD (P=0.05)	3.37	3.18	NS	NS	NS	88.87	32.88	NS	NS	NS	2.94
N levels (kg/ha)											
N0	35.32	45.24	69.34	11.92	3.86	273.80	142.93	2.25	0.67	41.98	23.31
N80	38.88	46.01	70.16	12.83	3.62	460.01	207.84	2.24	0.63	80.31	39.63
N120	40.21	50.69	74.32	13.29	3.74	652.03	331.04	2.32	0.65	113.80	56.63
N160	36.43	51.52	80.61	14.32	4.06	790.17	392.30	2.50	0.71	138.69	59.05
SEm ±	1.84	1.72	5.58	0.68	0.05	34.98	12.94	0.10	0.01	6.60	1.16
CD (P=0.05)	NS	5.30	NS	NS	NS	102.61	37.95	NS	NS	19.37	3.40

nitrogen in grain and straw, respectively.

Effect of nitrogen

The 1000-grain weight remained unaffected due to various levels of nitrogen. However 1000-grain weight was highest (40.21 g/ha) with 120 kg/ha. Grain and straw yield of wheat was maximum with 160 kg N/ha which was significantly higher over no nitrogen. Nitrogen content and protein content in grain and straw were not effected significantly due to nitrogen levels but these were maximum with 160 kg N/ha. Protein yield in grain and straw increased significantly with increasing level of nitrogen, yield of protein was highest with 160 kg N/ha in grain and straw. Application of 160 kg N/ha produced 71.7 and 21.19% higher protein yield in grain over 80 kg N/ha and 120 kg N/ha.Uptake of nitrogen in wheat grain and straw was significantly increased with increasing levels of nitrogen.

Among the various levels of nitrogen, 160 kg N/ha recorded the highest (138.69 and 59.05). Nitrogen uptake in grain and straw. 80 kg N/ha recorded the lowest (80.31 and 39.63 kg N/ha) nitrogen uptake in grain and straw, respectively. The increases in yield of protein and uptake of nitrogen owing to N resulted from increase in growth yield attributes and yield, similar increase in yield of grain, straw, protein yield and nitrogen uptake were also observed by Sharma and Dhillon (2002).

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EFFECT OF DIFFERENT LEVELS OF NUTRIENTS ON YIELD AND YIELD ATTRIBUTES OF TWO VARIETIES OF SCENTED RICE CV. PUSA BASMATI-1 AND HARYANA BASMATI

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ABSTRACT

A field experiment was conducted during *kharif* season of 2001 at Crop research Farm, Department of Agronomy, Allahabad Agricultural Institute-Deemed University, Allahabad, to study the effect of different levels of nutrients on yield and yield attributes of two varieties of scented rice cv. Pusa Basmati-1 and Haryana Basmati. The experiment was laid out in factorial 2x4 randomized block design with three replications. The treatments consisted of two varieties (Pusa Basmati-1 and Haryana Basmati) and four NPK levels (80:40:40:,100:50:50, 120:60:60 and 140:70:70 NPK/ha). The growth parameters, *viz.* plant height, number of tillers/hill and dry weight and yield attributes viz. number of filled grains/ panicle test weight and harvest index and yield parameters viz. grain, straw and biological yield were significantly improved due to application of (120:60:60 NPK kg/ha) as compared to other fertilizer levels of NPK. Among the varieties Pusa Basmati-1 showed better response in growth, yield attributes and yield parameters.

Key words : Basmati rice, nutrient levels, yield attributes, yield.

The major nutrients required by rice are nitrogen, phosphors and potassium. An adequate supply of nitrogen in the early stages is essential for growth, tillers, root activity and dry matter production in rice. Phosphors is also needed for normal growth and yield of rice. Even though rice soils in India are fairly rich in potassium, it is also needed for maturity and yield of rice.

MATERIALS AND METHODS

An experiment with two varieties of scented rice cv. Pusa Basmati-1 and Haryana Basmati was conducted at Crop Research Farm, Department of Agronomy, Allahabad Agricultural Institute-Deemed University, Allahabad, UP during *kharif* 2001. The soil of the experimental plots was sandy loam with pH 8.1. The experiment was laid out in 2x4 factorial RBD with eight treatments in three replications. The first factor consisting of two varieties (Pusa Basmati-1 and Haryana Basmati) and the second factor consisted of 4 levels of N:P:K *viz.* 80:40:40, 100:50:50, 120:60:6 and 140:70:70 kg/ha. Half dose of nitrogen and full dose of phosphorus and potash was applied as basal application and the rest of nitrogen was applied in two split doses at maximum tillering stage and at panicle initiation stage *i.e.* 30 and 60 DAT, respectively. The observations recorded were plant height, dry weight, number of effective tillers/hill, length of panicle, number of filled grains/panicle, test weight, harvest index, grain yield and straw yield. Net return and benefit cost ratio were worked out for the treatments.

RESULTS AND DISCUSSION

Growth and yield attributes

Pusa Basmati-1 produced significantly higher plant height and dry weight/hill over Haryana Basmati. Application of 140:70:70 NPK kg/ha produced significantly higher plant height and dry weight over 120:60:60, 100:50:50 and 80:40:40 NPK kg/ha. Similar results were observed by Reddy *et al.* (1998). Significantly higher values of yield attributes *viz.*, number of effective tillers/hill, number of filled grains/ panicle and harvest index were recorded in Pusa Basmati-1 with the application of 120:60:60 NPK kg/ha as compared to Haryana Basmati (Table 1). The values were significantly higher in Pusa Basmati-1 during the research due to better growth and development of panicle and better genetic make up.

Grain yield

Pus Basmati-1 produced significantly higher grain yield over Haryana Basmati. Application of 120:60:60 NPK kg/ha produced higher grain yield as compared to 140:70:70, 100:50:50 and 80:40:40 NPK kg/ha. Optimum dose of NPK produced higher grain yield. It might be due to higher absorption of nutrients. Similar results were observed by Chaudhari *et al.* (1998), Singh *et al.* (1997) and Thakur *et al.* (1997). Pusa

Table 1. Effect of different levels of inorganic fertilizers on growth parameters and yield attributes of two varieties of scented rice

Treatment	Plant height (cm)	Dry weight (g) tillers/hill	Number of effective (cm)	Length of panicle panicle	Number of filled grains/	Test weight (g)
Varieties						
Pusa Basmati^{-1}	123.78	119.69	12.53	28.19	124.89	19.6
Haryana Basmati	105.79	112.87	12.48	27.50	131.17	19.03
S Em ±	0.79	1.12	-	-	-	-
CD at 5%	1.70	2.40	NS	NS	NS	NS
Levels of NPK (kg/ha)						
80 : 40 : 40	112.48	107.90	11.25	27.75	122.95	19.80
100 : 50 : 50	111.97	110.50	12.98	27.71	132.08	19.13
120 : 60 : 60	116.93	118.30	13.22	28.54	135.58	19.10
140 : 70 : 70	118.05	128.42	12.88	27.38	121.50	19.21
S Em ±	1.12	1.58	0.42	-	4.74	-
CD at 5%	2.40	3.39	0.90	NS	10.17	NS

Table 2. Effect of different levels of inorganic fertilizers on harvest index, yield parameters and economics of two varieties of scented rice

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	Net return (Rs/ha)	Benefit cost ratio
Varieties					
Pusa Basmati^{-1}	38.90	111.58	37	17924	1.78
Haryana Basmati	32.66	126.12	36	12838	1.57
S Em ±	0.25	0.43	-	-	-
CD at 5%	0.53	0.92	NS	-	-
Levels of NPK (kg/ha)					
80:40:40	28.85	100.70	345	10209	1.49
100:50:50	39.18	111.78	35	18704	1.84
120:60:60	41.36	123.93	3922	20140	1.86
140:70:70	33.72	138.97	40	12472	1.53
S Em ±	0.35	0.60	0.012		
CD at 5%	0.76	1.29	0.026		

Basmati-1 produced the highest net return (Rs 17924/ha) and benefit : cost ratio (1.78). The application of 120:60:6 NPK kg/ha showed maximum net return (Rs. 2014/ha) and benefit : cost ratio (1.86).

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PERFORMANCE OF VERY LATE-SOWN BREAD WHEAT CULTIVARS AS INFLUENCED BY DIFFERENT LEVELS OF NITROGEN IN THE VERTISOLS OF CENTRAL INDIA

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ABSTRACT

Soybean (*Glycine max* (L) Merr.)-wheat is the common cropping system in Vertisols of central India. High temperature prevailing during reproductive phase of the late-planted wheat crop, affect the grain filling adversely. Field experiments were conducted for two consecutive spring (January to April) seasons of 2000 to 2001 with 4 promising varieties of bread (*Triticum aestivum* L. emend. Fiori. and Paol.) wheat of late sown groups, and 5 levels of N. The study objective was to (i) identify bread wheat cultivars suitable for late planting in the newly established, soybean-potato-wheat multiple cropping system; and (ii) determine the response of these bread wheat varieties to different levels of N application under very late sown conditions. Each year these cultivars were planted very late in January. The grain yield was significantly influenced upto 90 kg N/ha. The yield obtained at 90 and 120 kg N/ha was statistically similar. Among the bread wheat varieties, HI 977 gave significantly higher yield than other but it took maximum duration for maturity. The bread wheat varieties, GW 173 and HI 1418 with early maturity and yield level of 4.0 tones/ha proved promising under very late planting heat stress environment and may fit well in soybean-potato-wheat cropping system in central India.

Key words : Bread wheat, nitrogen, Vertisols, Central India.

Agriculture in central India is largely wheat based. Soybean-wheat is the common cropping system in the region after introduction of soybean in mid-1980s. In this system, wheat is normally planted in mid-November and harvested in early April. Recently, soybean-potato-wheat system has been introduced in the region, which has become popular among farmers with irrigation facilities (Anonymous, 2001). In this crop sequence, wheat is panted very late during 1st fortnight of January instead of normal sowing in mid-November, after the harvest of potato crop. Late-planted wheat crop suffers from high temperature stress, which coincides with grain development, as a result the length of the grain filling period is considerably reduced and ultimately resulting in low yields (Al-khatib and Paulsen, 1984; Ruwali *et al.* 1988). Grain and straw yields, and growth of wheat were significantly reduced by delayed sowing from 15th November to 15th December, with the rate of reduction approximately 45 kg grain/ha/day (Virender *et al.* 2002).

High temperature coupled with water stress (due to high evaporative demand and quick drying of soil) is common during grain filling in semi-arid climate. However, it is often difficult to distinguish the main causes of yield reduction, when both stresses overlap, as there are many apparent similarities in the response of grain filling to water stress and heat stress. Water stress followng heading has little effect on the rate of grain filling, but its duration (time from fertilization to maturity) is shortened and grain dry weight at maturity is reduced (Khanna - Chopra *et al.* 1994).

The yield potential of timely sown bread wheat was realized by applying 160 kg N + 60 kg P_2O_5 and 40 kg K_2O/ha (Chauhan *et al.*, 1996.). Under very late-sown condition, fertilizer requirement may be less due to reduced growth and duration to maturity. Under the increased fertilizer price, right dose of fertilizer application and choice of genotype performing better with a low fertilizer application are of great importance in order to increase fertilizer use efficiency. Taking the above in to consideration, a study was conducted with the objective to (i) identify bread wheat cultivars suitable for late planting in the newly established, soybean-potato-wheat multiple cropping system; and (ii) determine the response of these bread wheat varieties to different levels of N application under very late-sown conditions.

MATERIALS AND METHODS

Field experiments were conducted at the Indian Agricultural Research Institute, Regional Station, Indore (MP), India for two consecutive years from 2000 to 2001 with 4 varieties (GW 173, HI 1418, LOK 1 and HI 977) of bread wheat and 5 levels of nitrogen (0, 30, 60, 90 and 120 kg/ha). The experiment was laid out in spit plot design with 4 replications; keeping N levels in main plot and varieties in subplot.

The area has a semi-arid tropical climate with mean annual rainfall of 700 mm. The dominant soil type is Vertisol (very fine clay loam hyperthermic Typic Haplustert) (Soil Survey Staff,1975), highly calcarious and slightly alkaline. The initial characteristics of the top (0-15 cm depth) soil are given in Table 1.

The crop was sown very late on 7th January each year (26th December to 15th January is considered as very late for central India) and harvested during 2nd fortnight of April. A gross plot size for each treatment was 5x4 m. An initial population density of 240 plants per m^2 was maintained. Plant rows were spaced 20 cm apart oriented east-west. The seeds were treated with fungicide carbendazim (Bavistin)TM @ 2g/kg of seed. A fertilizer dose of 26.2 kg P and 33.3 kg K/ha was applied uniformly to all the treatments. Half N and full dose of P and K in the form of urea, single suerphosphate and muriate of potash respectively were applied at the time of sowing. Remaining half of the N was top-dressed in the form of urea at crown root initiation (CRI) along with first irrigation. Five flood irrigations each of 6 cm depth were applied in basin at CRI, late tillering, jointing, flowering and grain filling stages of wheat as per the recommendation (Bharadwaj *et al.*, 1975).

Table 1. Soil characteristics of the top layer (0-15 cm) prior to initiation of the study

Physico-chemical properties	Composition
Availabe N (kg/ha)	248
Organic C (g/kg)	5
Available K (kg/ha)	402
Available P (kg/ha)	12.4
EC (dS/m)	0.2
$CaCO_3$ (g/kg)	21.4
PH (1:2.5:: Soil:water)	8.0
Soil water content :	
At 33 kPa (% by weight)	32.5
At 33 kPa (% by weight)	17.5
Soil texture :	
Sand (%)	17
Silt (%)	28
Clay (%)	55

Observations were recorded on grain yield from a net plot area of 15 m^2. The yield attributes such as above ground biomass, spikes/m^2 and 1000-grain weight were recorded from the representative samples of 1m^2 from each treatment. The harvest index was calculated as the ratio of grain mass to total above ground biomass. The data at which 50% spikes in a pot turned brown was recorded as the date of physiological maturity. The grain and dry matter yield of wheat were reported at 14% moisture and oven dry weight basis, respectively.

The data were analyzed individually for each year as well as pooled for the two years of experimentation using standard analysis of variance (ANOVA) technique (Gomez and Gomez, 1984) with the help of MSTAT-C software (MSTATC, 1990). The significance of treatment effect was determined using the F-test and to determine the significance of difference between the means of two treatments, least significance difference (LSD) were estimated at the 0.05 level.

RESULTS AND DISCUSSION

Effect of nitrogen on yield and yield attributes

Nitrogen influenced the grain yield significantly. With increasing levels of N, the grain yield increased significantly up to 90 kg N/ha (Table 2). However there was no significant response to nitrogen between 90 and 120 kg/ha

Table 2. Yield and yield attributes of different bread wheat varieties as influenced by different N levels under the heat stress environment in Central India. (Pooled mean)

Treatment	Grain yield (kg/ha)	Spikes/ m^2	Grains/ spike	1000-grain weight	Dry matter (g/m^2)	Harvest index	Grain yield (g/m^2)	Physiological maturity (days)
Nitrogen level								
N_0	2085	221	32.2	47.88	486	0.482	232	98
N_{30}	3513	305	33.6	52.2	843	0.466	392	99
N_{60}	4224	328	34.30	48.42	905	0.452	409	100
N_{90}	4580	333	38.50	47.09	982	0.450	442	101
N_{120}	4761	372	38.60	46.20	1057	0.441	467	102
CD (P = 0.05)	252	24	2.48	2.38	68.6	0.032	31.2	
Varieties								
GW 173	3860	328	34.27	45.77	765	0.501	392	95
LOK-1	3549	325	31.07	53.37	837	0.467	388	97
HI 1418	3842	289	38.45	48.41	840	0.463	387	95
HI 977	4080	305	36.90	45.81	905	0.436	394	114
CD (P = 0.05)	157	22.0	2.45	2.31	66.9	0.030	27.3	

in vertisols of central India under very late panting situations. The yield attributes, spikes/m^2, grains/spike, dry-matter accumulation, harvest index and grain yield/m^2 increased significantly with increasing levels of N. However, 1000-grain weight increased with increasing level of N from 0 to 30 kg/ha, there after, it showed a decreasing trend even up to 120 kg/ha. Duration to maturity also increased with increasing levels of N.

Performance of varieties

The performance of varieties under very late-sown conditions differed significantly (Table 2). The maximum grain yield of 4080 kg/ha was recorded in case of HI 977, which was significantly superior to all other cultivars. Performance of GW 173 and HI 1418 were statistically similar, but they were significantly superior to LOK 1. Yield attributes, spikes/m^2, grain/spike, 1000-grain weight, dry matter accumulation, harvest index and grain yield/m^2 were significantly differed among the varieties. The maximum spikes/m^2 and harvest index were recorded in GW 173, while maximum grains/spike in HI 1418 and 1000-grain weight in LOK1. Maximum dry matter accumulation and grain yield/m^2 were recorded in HI 977. HI 977 took maximum duration to maturity and it was the lowest for HI 1418 and GW 173.

Interaction between levels of N and varieties was significant (Table 3). The performance of HI 977 was superior in all the N levels except at 120 kg N/ha, where maximum grain yield was recorded for HI 1418 followed by GW 173. GW 173 produced higher grain yield than HI 1418 and LOK 1 in all the N levels except at 30 kg N/ha, where it produced at lowest grain yield and at 120 kg N/ha, where it was inferior to HI 1418 and superior to HI 977 and LOK 1. The highest grain yield was obtained with HI 1418 at 120 kg N/ha. While the lowest grain yield was obtained with LOK 1 at 0 kg N/ka.

The low grain yield of HI 977 at 120 kg N/ha was due to lodging of the variety. Again, it matured late among the all varieties and some times late maturing varieties are subject to hailstorm towards harvesting of the crop which incurs heavy loss in grain yield. LOK 1 was a bold seeded variety, not preferred by some farmers, as the variety was susceptible to leaf rust in very late planting and lodging under higher fertility situations.

High temperature stress during reproductive growth is major cause of poor

Table 3. Interaction effect of N levels and bread wheat varieties on grain yield (kg/ha) of very late-sow conditions in central India (pooled mean)

Varieties	N_0	N_{30}	N_{60}	N_{90}	N_{120}	Mean
GW 173	2150	3180	4425	4657	4889	3860
LOK-1	1944	3396	3746	4289	4369	3549
HI 1418	1972	3685	4025	4615	4914	3842
HI 977	2272	3792	4701	4759	4872	4080
Mean	2085	3513	4224	4580	4761	
					CD (P=0.05)	
For sub plots at same level of main plots					352	
For two main plots at same or different levels of sub plots					368	

yields for late sown wheat. In central India, when late-sown, maximum/minimum temperatures during grain filling were higher by about 3-4°C for mid-December sowing and 5-6°C for mid-January sowing, compared to normal (mid-November) sowing, where temperatures were 30-31°C/11-12°C (Ruwali and Prasad, 1991). The optimum mean temperature for maximizing yield of spring wheat, a temperate cereal, is 17.5°C (Fisher and Byerlee, 1991). However, in this study, the mean temperature during the crop season varied between 16.8°C and 31.1°C, which was higher than the optimum requirement. The late-sown wheat crop experienced heat stress during a larger portion of grain filling and reproductive stage. which were the most sensitive to heat stress. High temperature also influences the duration to flowering and grain filling (Viswanathan and Khanna-Chopra, 2001). A multilocational coordinated trial conducted in 6 centres including Indore in central India with similar cultivars reported significant reduction of 16% grain yield under late sowing compared to normal sowing. This was attributed to reduction in biomass, spikes/m^2, grains/spike and 1000-grain weight of varying degrees (DWR, 1997). The 1000-grain weight is the most adversely affected trait under heat stress environment. Heat stress reduces the grain weight through reduction in grain duration and grain growth rate (Tasiro and Wardlaw, 1990).

CONCLUSION

Heat tolerance varied among the varieties. Wheat varieties responded significantly up to 90 kg N/ha. Bread wheat cultivars, GW 173 and HI 1418 with early maturity and yield levels of 4.0 tones/ha at 90 kg N/ha proved promising under very late planting heat stress environment and may fit well in soybean-potato-wheat cropping system in central India.

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EFFECT OF SOWING DATES AND NITROGEN LEVELS ON NODULATION AND GREEN POD YIELD OF PEA (*PISUM SATIVUM*)

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ABSTRACT

Study on root nodulation and pea pods production as influenced by different sowing dates and nitrogen levels was carried out at Horticulture Research and Extension Centre, Chakrata, Dehradoon during 2005. Pea seeds inoculated with *Rhizobium* were sown in 4 dates from 10 January to 25 February at fortnightly intervals with the application of 3 levels of nitrogen @ 0, 20 and 40 kg N/ha. The pattern of nodule formation on roots was recorded. Maximum nodules on main root were seen in early sowings with higher level of nitrogen. Similarly the rate of dry matter accumulation in nodules was highest in early sowing with higher level of nitrogen due to more period of transition from vegetative to reproductive phase and more nitrogen fixation in field. The green pod yield was highest in higher level of nitrogen due to influence of more nodulation as reflected by higher nodule weight.

Key words : Pea, sowing dates, nitrogen levels, pod yield.

In hills, green pea is grown as off season vegetable crop due to variation in temperature and humidity at different altitudes. Disease free green pod yield with increasing pod length, pod number and pod weight can be obtained at optimum temperature (Lie, 1971 and Reponen *et al.*, 1970). The effectiveness of root nodules in fixing the nitrogen is also associated with the application of appropriate amount of nitrogen (Bergersen, 1973). In view of this, an experiment was laid out to see the effect of sowing dates and nitrogen levels on nodulation and green pod yield of pea variety Arkel.

MATERIALS AND METHODS

The experiment was conducted during *rabi* season in the year 2005 at Horticulture Research and Extension Centre, Chakrata, Dehradoon. Pea seeds (variety Arkel) were sown on 4 dates i.e. 10 January, 25 January, 10 February and 25 February with the application of 3 nitrogen levels @ 0 kg N/ha, 20 kg N/ha and 40 kg N/ha through urea and 12 treatments were replicated thrice in a randomized block design. The soil analysis values of the experimental field were: pH 6.6 and organic carbon percent 9.5. Seeds were sown @ 100 kg /ha in rows drawn 30 cm apart. Five roots were sampled from each treatment at the green pod development stage and the nodules were counted, removed and dry weight was recorded after drying them to a constant weight in oven at 65°C. The green pods were picked when green peas in pods attained 70 percent maturity and the pickings were done at weekly intervals. The observations on green pod yield per m^2 area in weight, average pods length and total weight of green pod yield per hectare were recorded.

RESULTS AND DISCUSSION

The nodulation was found significantly affected by the sowing dates and nitrogen levels at all stages of plant growth and pod development (Table 1). Increasing tendency of nodule formation in the crop in early sowing on 10 January and onwards on 25 January with higher level of nitrogen shown decreasing tendency of nodule formation. Similarly the nodules weight was also found significantly higher in early sowing date with higher level of nitrogen. Lie (1971), Masefield (1971), and Bergersen (1973) have also reported that the satisfactory nodulation depended on temperature.

Table 1. Effect of sowing dates and nitrogen levels on root nodulation ad green pod yield of pea variety Arkel

Sowing date	Nitrogen levels	Nodules/ plant	Nodules dry weight (mg/ plant)	Green pod yield (kg/m^2)	Pea pod length (cm)	Green pod yield (q/ha)
10 January	0 kg N/ha	12.3	18.8	0.820	6.23	82.00
	20 kg N/ha	20.7	41.8	1.100	6.80	110.00
	40 kg N/ha	35.5	52.7	1.220	7.88	122.00
25 January	0 kg N/ha	15.8	22.0	0.840	6.14	84.00
	20 kg N/ha	24.5	46.2	1.462	7.20	146.20
	40 kg N/ha	38.6	54.5	1.500	8.10	150.00
10 February	0 kg N/ha	12.5	18.2	0.810	6.19	81.00
	20 kg N/ha	12.5	18.2	0.810	6.19	81.00
	40 kg N/ha	34.7	51.2	1.200	7.50	120.00
25 February	0 kg N/ha	10.0	12.0	0.720	6.00	72.00
	20 kg N/ha	18.5	30.5	0.910	6.41	91.00
	40 kg N/ha	27.3	42.1	1.010	6.55	101.00
CD at 5%	Sowing dates	3.28	5.66	0.250	0.32	8.10
	Nitrogen level	5.50	7.10	0.440	0.57	13.15
	Interaction (Sowing dates x nitrogen level)	7.10	8.90	0.632	0.62	16.10

The highest green pod yield per m^2 area was recorded when the sowing was done on 25 January with the higher level of nitrogen due to maximum root nodulation and symbiotic nitrogen fixation. This may also be due to more period of transition from vegetative to reproductive phase and more availability of nitrogen to the crop. Late sowing always decreased the green pod length, weight and total yield due to minimum plant growth and low percentage of seed germination rate. Reponen *et al.* (1970) and Lie *et al.* (1976) have also reported increasing and decreasing trends of pea yield due to environmental effects on nodulation and nitrogen fixation.

Thus it was clear that the early sowing of pea seed on 25 January with higher level of nitrogen @ 40 kg/ha was found suitable for highest green pod yield under hill conditions.

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RESPONSE OF BROADBEAN (*VICIA FABA* L.) TO ROW SPACING AND PHOSPHORUS UNDER LATE SOWN RAINFED CONDITION OF MANIPUR

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ABSTRACT

A field experiment was conducted at Imphal to evaluate the effect of spacing and phosphorus on nodulation, yield and quality of broadbean under late sown rainfed condition of Manipur during *rabi* seasons of 2002-03 and 2003-04. On the basis of two years result, the highest nodulation, seed yield and crude protein content was associated with the application of 60 kg P_2O_5/ha which was significantly superior to all other levels of phosphorus except for the crude protein content which remained on par with 40 kg P_2O_5/ha, Though significantly higher nodulation and crude protein content of the seed was recorded in wider spacing of 40x10cm, the highest seed and stover yield were recorded in the closer spacing of 20 x 10 cm.

Key words : Broadbean, spacing, phosphorus.

Broadbean is one of the important *rabi* pulse crops of Manipur cultivated after the harvest of the *kharif* paddy. Out of 16, 123 hectares of area under *rabi* pulse in Manipur, broadbean occupies an area of 5, 250 hectares (Anon. 2002). To bridge the gap between production and requirement of of pulses in the state, productivity has to be increased through development of sound agronomic package. Of the various practices, the role of spacing and phosphorus are vital. The present investigation deals with these aspects.

MATERIALS AND METHODS

A field experiment was conducted at College of Agriculture, CAU, Imphal during *rabi* seasons of 2002-03 and 2003-04. The soil of the experimental field was clay in texture, acidic in reaction (pH 5.5), high in organic carbon (3.3%), high in available nitrogen (457 kg/ha), medium in available P (18 kg/ha) and high in available K (347 kg/ha), medium in available P (18 kg/ha) and high in available K (347 kg/ha). The treatments consisted of three spacing (20 x 10 cm, 30 x 10 cm and 40 x 10 cm) and four levels of phosphorus 0, 20, 40 and 60 kg P_2O_5/ha). The experiment was laid out in factorial randomized block design with three replications. The local variety Hawaimubi maru achoubi was sown by dibbling on 6 December 2002 and 10 December 2003, respectively. *Rhizobium* treatment for the seed was done before sowing. A uniform dose of 30 kg N/ha and 40 kg K_2O/ha along with phosphorus as per treatments were given basally. The total rainfall received during the cropping season of 2002-03 and 2003-04 were 132 mm and 544 mm, respectively.

RESULTS AND DISCUSSION

Phosphorus

The seed and Stover yield and protein content increased significantly with every increase in the level of phosphorus up to 60 kg P_2O_5/ha (Table 1). Such increase in the seed yield with the application of phosphorus is obvious due to acid condition of the soil and the medium availability of phosphorus. In addition more number of clusters and pods/plant were recorded in this treatment resulting in higher seed yield. Crop fertilized with 60 kg P_2O_5/ha gave 68.32 and 14 per cent more yield over control, 20 and 40 kg P_2O_5/ha. Similar beneficial effect of phosphorous on yield was also reported by Srivastava and Srivastava (2000) and Khanda *et al.* (2001). Application of phosphorus increased early root growth and enhanced nodulation resulting in better vegetative growth of the plant, which might have stimulated crude protein

Table 1. Effect of spacing and levels of phosphorus on nodulation, yield and quality of broadbean (2 years pooled data)

Treatment	Nodules/ Plant 90 DAS	Dry wt. of nodules (mg) 90 DAS	No. of cluster/ plant	No. of pods/plant	Pod length (cm)	No. of seeds /pod	100 seed wt. (g)	Seed yield (q/ha)	Stover yield (q/ha)	Crude protein (%)
P_2O_5 levels										
0	33.62	34.48	8.23	17.53	5.53	2.46	48.52	7.61	19.54	31.00
20	34.04	37.59	8.87	17.92	5.51	2.93	49.82	9.73	24.63	31.56
40	34.76	38.65	9.14	18.63	5.55	3.11	50.67	11.19	28.09	32.25
60	35.1	43.00	9.54	18.98	5.61	3.23	51.49	12.80	30.19	32.94
CD (P=0.05)	0.40	2.29	0.15	0.43	NS	NS	NS	0.72	2.29	0.74
Spacing										
20x10cm	33.77	35.09	8.38	17.65	5.25	2.63	49.57	12.09	28.95	30.94
30x10cm	34.43	38.89	8.94	18.30	5.59	3.01	50.13	10.12	23.72	31.88
40x10cm	34.96	41.36	9.51	18.84	5.67	3.15	50.68	8.82	22.92	33.00
CD (P=0.05)	0.33	1.97	0.13	0.37	NS	NS	NS	0.68	1.97	0.64

content in seed. Singh and Sharma (2001) reported that application of phosphorous influenced the nutrient content of blackgram seed.

Spacing

The closely spaced plant produced higher seed yield due to more number of plants per unit area as compared to widely spaced plant. Though higher value of clusters and pods/plant were exhibited at wider spacing, lower seed yield was recorded due to less number of plants per unit area. The effect of narrow spacing has often been explained by the fact that thick canopy may intercept a large percentage of solar radiation, thereby increasing photosynthesis (Singh *et al.*, 1996). Closer spacing (20 x 10 cm) gave 20 and 37 per cent additional yield over 30 x 10 and 40 x 10 cm, respectively. However, wider spacing produced the maximum crude protein content in seed. Rath *et al.* (1997) reported the similar influence of spacing on nutrient content in rice-bean.

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MAXIMIZATION OF RICE (*ORYZA SATIVA*) YIELD THROUGH HEAVY FERTILIZATION AND ITS RESIDUAL EFFECT ON WHEAT (*TRITICUM AESTIVUM*) UNDER RICE-WHEAT CROPPING SYSTEM

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ABSTRACT

A field experiment comprised of fourteen treatment combinations was conducted during 2000-01 and 2001-2002 to study the influence of high fertility on the productivity of low land rice and their residual effect on wheat. Treatment N_{175} P_{100} K_{175} Zn_{60} produced maximum number of panicles, test weight, harvest index and the grain yield to the tune of 72.94 q/ha being 32.97 percent higher than N_{100} P_{100} K_{175} Zn_{60}. Grain yield of rice started reducing by the application of N over 175 kg/ha at constant or varied levels of P_2O_5, K_2O and $ZnSo_4$. The response of P was found significant only at the highest level of 100 kg/ha, while the levels of K and Zn did not have any distinguish effect on rice. The grain yield of wheat 21.47 q/ha was recorded when grown under residual fertility of the highest rice yield producing treatment N_{175} P_{100} K_{175} Zn_{60}, which was 16.07 percent lowerer than the treatment N_{225} P_{100} K_{175} Zn_{60} that recorded 25.58 q grains/ha. The best response of residual fertility was realized under the maximum dose of P (100 kg P_2O_5/ha) coupled with other nutrients at their highest levels. The higher quantity of $ZnSO_4$ @ 60 kg/ha may be regarded as beneficial dose to wheat grown under residual fertility treatments.

Key words : Fertility level, yield maximization, residual effect, rice-wheat.

India needs about 325 million tonnes of food grains to feed an expected population of about 1.5 billions by 2025 A.D. Taking the current food production level into consideration, India has a compulsive need to raise food production by 5 mt per year as against 3.1 mt per year achieved over the past 50 years (Ghosh *et al.* 1999). The possible option to achieve this aim is to refine the application of available knowledge to reduce the available gap between 'realizable' and 'actually realized' yield. This implicitly calls for adoption of best management practices, involving judicious and balance use of input. 'Maximum Yield Research' (MYR) is a step in this direction. The MYR studies conducted during 1986 to 1989 in Punjab indicated that it was possible to harvest the yield up to 10 t/ha of rice (unhusked) and 6t/ha of wheat by use of only chemical fertilizers because of both the crops are heavy feeders. As per an estimate, a system yielding 7t/ha rice and 4 t/ha wheat may remove as much as 316 kg N, 84 kg P_2O_5 and 401 kg K_2O, apart from significant amount of different secondary and micro-nutrients. This amount of nutrient removal warrants proper nutrient management so as to achieve high and sustainable crop productivity. The intensive cropping should also aim to exploit the residual effects of applied fertilizer to provide fertilizer economy and efficient crop production. An investigation was therefore, carried out to study the influence of high fertility on the productivity of low land rice and its residual effect on wheat in rice-wheat cropping system.

MATERIALS AND METHODS

A field experiment was conducted at Crop Research Centre, G.B. Pant University of Agriculture & Technology, Pantnagar during 2000-01 and 2001-02, in randomized block design with 4 replications. The soil of experimental field was silty loam, neutral in reaction (pH 7.4), high in organic carbon (1.09%), low in available nitrogen (227 kg/ha) and zinc (0.8 ppm), medium in available phosphorus (18.7 kg/ha) and potassium (190 kg/ha). The treatments consisted of fourteen fertility levels supplying NPK and Zn to rice cultivar Pant Dhan-4 were : T_1- N_{100} P_{100} K_{175} Zn_{60}; T_2- N_{125} P_{100} K_{175} Zn_{60}; T_3- N_{150} P_{100} K_{175} Zn_{60}; T_4- N_{175} P_{100} K_{175} Zn_{60}; T_5- N_{200} P_{100} K_{175} Zn_{60}; T_6- N_{225} P_{100} K_{175} Zn_{60}; T_7- N_{225} P_{25} K_{175} Zn_{60}; T_8- N_{225} P_{50} K_{175} Zn_{60}; T_9- N_{225} P_{75} K_{175} Zn_{60}; T_{10}- N_{225} P_{100} K_{100} Zn_{60}; T_{11}- N_{225} P_{100} K_{125} Zn_{60}; T_{12}- N_{225} P_{100} K_{150} Zn_{60}; T_{13}- N_{225} P_{100} K_{175} Zn_{20}; T_{14}- N_{225} P_{100} K_{175} Zn_{40}. To asses the residual effect of high fertility treatments, the wheat cultivar UP-2338 was grown as succeeding crop without distorting the layout plant of preceding crop. Rice seedling of 25 days old were transplanted at 20 cm x 10 cm spacing under puddled conditions keeping two seedlings per hill on July 16 and 06 of 2000 and 2001, respectively. While, the wheat crop was sown on November 21 and 24 of 2000 and 2001, respectively as per standard package and practices under residual fertility conditions. The sources of nutrients applied to rice were urea, DAP, MOP and zinc sulphate. One third amount of urea with full amount DAP, MOP and Zn were given as basal dose while remaining amount of urea was applied into two equal splits at tillering and panicle initiation stage. The amounts of rainfall received during both the years were 113 and 136 cm, respectively.

RESULTS AND DISCUSSION

Effect on rice

The grain yield was significantly influenced due to the fertility treatments applied to rice, while the straw yield stayed unaffected. The improvement in the grain yield was witnessed only up to the application of 175 kg N/ha (T_4). The response of P was significant only at the highest level of 100 kg P_2O_5/ha. While, each increment in the level of K_2O and Zn, respectively by keeping other nutrients at constant maximum level, did not furnished any fruitful gain. Treatment N_{175} P_{100} K_{175} Zn_{60} being at par with N_{200} P_{100} K_{175} Zn_{60}. N_{225} P_{100} K_{175} Zn_{60} and N_{225} P_{100} K_{175} Zn_{20}, produced 72.95 q grains/ha, which were 32.97% higher than N_{100} P_{100} K_{175} Zn_{60}.

The increase in rice yield may be assigned to higher no. of panicles/unit area and grains of more weight. Besides the continuous and matching supply of N through applied fertility treatments and balanced fertilization might also be responsible for fastening the photosynthetic activity and vigorous vegetative growth. These results were in close conformity of Desmukh and Tiwari (1996). As the level of N increased beyond 175 kg/ha (T_4), a slight reduction in grain yield of rice was observed. This reduction was 7.4 and 9.6 over the highest yielder treatment N_{175} P_{100} K_{175} Zn_{60}. It was owing to the application of higher doses of N which caused lodging at grain filling stage. The higher concentration of N also decreased the lignin and hemi-cellulose contents of plants which produced elongated and weaken shoots that were prone to lodging. This finding was in accordance with Lee *et al.* (1989).

The data summarized in the Table 1 revealed that there was no marked difference in plant height of rice. However, it increased with increasing level of nitrogen. The tallest plants were observed by the treatment N_{225} P_{100} K_{175} Zn_{60}, where highest dose of all these nutrients were tried. It might be due to better root development, more cell division and cell elongation under higher level of nitrogen and phosphorus as well as favourable effect of zinc on biosynthesis of plant growth hormone (IAA) that in turn might have favoured the plant height.

The statistical variations in dry matter accumulation due to different fertility treatments were also observed. Treatment N_{175} P_{100} K_{175} Zn_{60} being at par with N_{200} P_{100} K_{175} Zn_{60}, N_{225} P_{100} K_{175} Zn_{60} and N_{225} P_{100} K_{175} Zn_{20}, recorded the highest dry matter accumulation being 46.04% higher than the lowest dry matter accumulation N_{100} P_{100} K_{175} Zn_{60}. The higher crop growth rate at higher level of nutrients might be resulted in the accumulation of relatively more dry matter through increased photosynthetic efficiency due to optimum leaf area.

Grains/panicles and panicles/m^2 had their profound effect in contribution of grain yield, while test weight had nothing, among the yield attributing characters. The no. of grains/panicles increased with each increment in the level of N only up to 150 kg/ha with constant maximum levels of other (T_3). The maximum no. of grains/panicles was counted under treatment N_{175} P_{100} K_{175} Zn_{60}, which was found at par with N_{200} P_{100} K_{175} Zn_{60}, N_{225} P_{100} K_{175} Zn_{60} and N_{225} P_{100} K_{175} Zn_{20}.

Table 1. Effect of yield maximization treatments on the growth and yield of rice (pooled data)

Treatments	Plant ht.(cm)	Dry Matter (g/5hill)	Panicles (m^{-2})	Test wt. (g)	Grains ($panicle^{-1}$)	Grain yield (q/ha)	Straw yield (q/ha)
$N_{100} P_{100} K_{175} Zn_{60} (T_1)$	105.5	125.3	251	27.85	95	54.86	76.44
$N_{125} P_{100} K_{175} Zn_{60} (T_2)$	108.0	138.7	274	27.97	97	55.81	77.13
$N_{150} P_{100} K_{175} Zn_{60} (T_3)$	110.2	151.1	286	28.15	109	64.42	82.10
$N_{175} P_{100} K_{175} Zn_{60} (T_4)$	130.0	183.0	328	28.98	121	72.95	81.83
$N_{200} P_{100} K_{175} Zn_{60} (T_5)$	115.4	165.0	320	28.75	114	67.92	79.76
$N_{225} P_{100} K_{175} Zn_{60} (T_6)$	117.5	161.2	307	28.59	112	66.51	85.73
$N_{225} P_{25} K_{175} Zn_{60} (T_7)$	109.2	146.9	276	27.77	95	56.34	76.49
$N_{225} P_{50} K_{175} Zn_{60} (T_8)$	113.0	151.4	285	28.04	100	58.96	76.43
$N_{225} P_{75} K_{175} Zn_{60} (T_9)$	112.1	154.9	292	28.23	102	62.35	80.71
$N_{225} P_{100} K_{100} Zn_{60} (T_{10})$	111.0	155.9	299	28.33	108	64.28	81.55
$N_{225} P_{100} K_{125} Zn_{60} (T_{11})$	110.8	149.2	284	27.61	96	61.81	85.17
$N_{225} P_{100} K_{150} Zn_{60} (T_{12})$	111.9	153.6	290	28.03	96	62.74	88.48
$N_{225} P_{100} K_{175} Zn_{20} (T_{13})$	114.0	170.2	313	28.83	117	68.65	82.04
$N_{225} P_{100} K_{175} Zn_{40} (T_{14})$	110.1	153.0	302	28.02	96	63.49	86.44
Sem±	3.8	8.08	12.9	0.40	4.3	2.66	3.46
CD (0.05)	NS	23.10	37	NS	12	7.61	NS

Treatment $N_{100} P_{100} K_{175} Zn_{60}$ being at par with T_7 recorded minimum no. of grains/panicle. Nitrogen had its positive effect only up to 175kg/ha, while P up to 75, K up to 100 and Zn at its all levels of application by keeping all other nutrients at their constant maximum levels, on no. of panicles/m^2.

Treatment $N_{175} P_{100} K_{175} Zn_{60}$ being at par with $N_{200} P_{100} K_{175} Zn_{60}$, $N_{225} P_{100} K_{175} Zn_{60}$, $N_{225} P_{25} K_{175} Zn_{60}$, $N_{225} P_{75} K_{175} Zn_{60}$, $N_{225} P_{100} K_{100} Zn_{60}$, $N_{225} P_{100} K_{175} Zn_{20}$ and $N_{225} P_{100} K_{175} Zn_{40}$ generated 30.7% higher effective shoots than its lowest generator T_1. The optimum nutrient supply might have enhanced the photosynthetic accumulation which led to the production of higher no. of shoots/panicle.

Residual effect on wheat

The residual effect of heavy fertility treatments applied to rice varied significantly except test weight and straw yield (Table 2). The highest grain yield of wheat (25.58 q/ha) was recorded with treatment $N_{225} P_{100} K_{175} Zn_{60}$ applied to preceding rice crop. The grain yield under the treatments $N_{225} P_{100} K_{100} Zn_{60}$ and $N_{225} P_{100} K_{175} Zn_{40}$ remained at par with the previous highest yielder. The might be ascribed to the higher number of effective spikes and no. of grains/spike of more weight as well as dry matter accumulation.

Each increment made in the level of phosphorus statistically improved the grain yield. The best response was realized under the maximum dose of phosphorus (100 kg/ha) coupled with the other nutrients at their highest concentrations. It showed a explicit advantage of residual effects. Advantage of residual effect of P on wheat followed rice had also been reported by Patel *et al.* (1997). The grain yield under the treatments $N_{225} P_{100} K_{175} Zn_{20}$ and $N_{225} P_{100} K_{175} Zn_{40}$ were reduced to the tune of 17.73 and 14.08%, respectively when compard to out yielded treatment $N_{225} P_{100} K_{175} Zn_{60}$. Thus, higher quantity of $ZnSO_4$@ 60kg/ha may be regarded as beneficial dose to wheat grown under residual fertility treatments. Chhiba *et al.* (1989) was also of similar opinion.

The significant variation thus, observed in grain yield of wheat raised in sequence with rice might be assigned to the differences to the quantity of available nutrients left in soil after harvest of rice or might remain unutilized due to time required for the slow decomposable/fixed portion and subsequent release of its

Table 2. Growth and yield of wheat as affected by yield maximization treatments applied to rice (pooled data)

Treatments	Plant ht.(cm)	Dry matter (gm^{-1})	Spikes (m^{-2})	Test wt. (g)	Grains ($Spike^{-1}$)	Grain yield (q/ha)	Straw yield (q/ha)
$N_{100}\ P_{100}\ K_{175}\ Zn_{60}\ (T_1)$	78.8	204.72	235	42.57	28	18.17	52.94
$N_{125}\ P_{100}\ K_{175}\ Zn_{60}\ (T_2)$	79.5	213.06	252	43.45	30	19.90	54.37
$N_{150}\ P_{100}\ K_{175}\ Zn_{60}\ (T_3)$	80.7	219.93	261	44.08	31	20.00	55.46
$N_{175}\ P_{100}\ K_{175}\ Zn_{60}\ (T_4)$	81.7	224.40	283	44.30	32	21.47	55.86
$N_{200}\ P_{100}\ K_{175}\ Zn_{60}\ (T_5)$	83.2	232.50	287	44.52	33	21.92	56.09
$N_{225}\ P_{100}\ K_{175}\ Zn_{60}\ (T_6)$	87.7	256.66	305	45.40	41	25.70	63.86
$N_{225}\ P_{25}\ K_{175}\ Zn_{60}\ (T_7)$	82.1	163.97	174	41.82	25	12.64	47.13
$N_{225}\ P_{50}\ K_{175}\ Zn_{60}\ (T_8)$	83.6	198.62	222	42.75	27	16.20	53.41
$N_{225}\ P_{75}\ K_{175}\ Zn_{60}\ (T_9)$	85.1	219.24	281	43.78	31	19.75	59.91
$N_{225}\ P_{100}\ K_{100}\ Zn_{60}\ (T_{10})$	86.9	226.48	287	44.92	34	23.72	57.47
$N_{225}\ P_{100}\ K_{125}\ Zn_{60}\ (T_{11})$	83.7	219.90	226	42.55	28	17.21	53.96
$N_{225}\ P_{100}\ K_{150}\ Zn_{60}\ (T_{12})$	84.4	234.05	244	42.71	28	18.81	58.47
$N_{225}\ P_{100}\ K_{175}\ Zn_{20}\ (T_{13})$	85.3	239.91	265	44.80	32	21.21	59.34
$N_{225}\ P_{100}\ K_{175}\ Zn_{40}\ (T_{14})$	85.9	241.40	270	44.97	33	22.15	59.93
Sem ±	1.8	10.37	7.83	0.95	1.65	1.32	4.57
CD (0.05)	5.0	29.69	23	NS	5.00	3.77	NS

nutrients through mineralization. Although, poor aggregation and physical conditions of soil resulted from the pudding in rice is one of the most serious constraints in production of wheat after rice.

The plant growth measured in terms of plant height and dry matter accumulation increased with the increment in the level of N applied to rice. The taller and sturdy plants were recorded under treatment $N_{225}\ P_{100}\ K_{175}\ Zn_{60}$, where the maximum doses of fertilizers were applied. It was found at par with treatments T_5 and from T_8 to T_{14} in case of plant height and with T_5, T_{12}, T_{13} and T_{14} in case of dry matter accumulation.

Application of heavy fertility treatment ($N_{225}\ P_{100}\ K_{175}\ Zn_{60}$) to rice brought positive effect on production of maximum no. of grains/spike. This response was found at par with treatment $N_{200}\ P_{100}\ K_{175}\ Zn_{60}$. $N_{225}\ P_{100}\ K_{100}\ Zn_{60}$ and $N_{225}\ P_{100}\ K_{175}\ Zn_{40}$. Treatment $N_{100}\ P_{100}\ K_{175}\ Zn_{60}$ being at par with T_7, T_8, T_{12} and T_{13} produced minimum no. of grains/spike. As the level of N applied to rice increased with higher level of other nutrients, the response to residual N in terms of no. of spikes/m^2 was increased. The significant response was observed only up to 175 kg N/ha applied to rice (T_4) being at par with $N_{200}\ P_{100}\ K_{175}\ Zn_{60}$ and $N_{225}\ P_{100}\ K_{175}\ Zn_{60}$. Treatment $N_{225}\ P_{25}\ K_{175}\ Zn_{60}$ had minimum residual effect in production of effective shoots.

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PERFORMANCE OF MAIZE (*ZEA MAYS* L.) + SOYBEAN [*GLYCINE MAX* (L.) MERRILL] INTERCROPPING SYSTEMS AT VARYING NUTRIENT LEVELS

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ABSTRACT

A field experiment was conducted at Rajasthan College of Agriculture, Udaipur during rainy season of 2003 and 2004 to study the performance of maize+soybean intercropping systems at different nutrient levels. Significant improvement in growth parameter and yield attributes were recorded with 2:2 in maize and soybean compare to 3:3 and 1:1 ratios, respectively. The highest maize equivalent yield (62.94 q/ha) and B:C ratio (3.43:1) were obtained with maize+soybean in 2:2 ratio at 30 cm apart. The increasing levels to fertility of maize and soybean significantly increased in yield, growth parameters, MEY and B:C ratio up to 75 per cent of recommended 90 kg N and 40 kg P with maize and 50 per cent of 60 kg N and 40 kg P of soybean, respectively.

Key words : Maize+soybean intercropping, growth parameters, yield attributes, row ratio, fertility levels.

Maize (*Zea mays* L.) is an important cereal crop of India and plays significant role in agriculture economy both as a staple food for human beings and feed for animals. In Rajasthan, it is grown on 1.02 mha with production of 1.48 mt (Vital Agricultural Statistics, 2002-2003). Being a widely spaced cereal, provide an opportunity of accommodation of short stature legumes. As a intercrop to utilize resources judiciously.

Intercropping of rain fed soybean with maize prove more productive and remunerative than mungbean (Jat, 1996). Soybean is considered an ideal crop for intercropping with maize owing to comparative tolerance for shade and drought, efficient light utilization and less competitiveness for soil moisture (Wright *et al.* 1988). The optimum row ratio and fertilizer schedule for obtaining optimum yield from maize+soybean intercropping system in the south Rajasthan has not bean worked out. Keeping this in view, present study was carried out during *kharif* 2003 and 2004.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Farm, Rajasthan college of Agriculture, Udaipur during rainy seasons of 2003 and 2004. The soil of the experimental field was clay loam in texture, alkaline in reaction and calcareous in nature. The soil was medium in organic carbon (0.79%), available nitrogen (265.5 kg/ha) and phosphorus (16.9 kg/ha) and high in potassium (377.4 kg/ha) with pH 8.9. The experiment was laid out in factorial RBD with three replications. The treatments comprised of three row ratio of maize + soybean (1:1, 2:2 and 3:3), three fertility levels for maize (100, 75 and 50 per cent recommended dose of 90 kg N/ha and 40 kg P/ha) , three fertility levels for soybean (100, 50 per cent recommended dose of fertilizer 60 kg N/ha and 40 kg P/ha and no fertilizer) and 2 absolute sole plots of maize and soybean. Maize cv. "Ganga Safed-2" and Soybean cv "JS-335" were sown in rows spaced at 30 cm apart for intercropping and sole soybean, sole maize and soybean were sowed at 60 and 30 cm spacing receptivity. Soybean plants were introduced while maintaining the population of sole maize in all the three row ratios. Sowing to seeds was done on 4 July in 2003 and 5 July in 2004. Before sowing, the seeds of soybean were inoculated with *Bradyrhizobium japonicum*.

RESULTS AND DISCUSSION

Maize

Data (Table 1) revealed that dry matter accumulation was significantly higher with 1:1 and 2:2 maize + soybean intercropping than 3:3 row ratio. Similarly leaf area index and grains/ cob recorded significantly higher with 1:1 and 2:2 ratios. The significant increase in growth parameters of maize under 1:1 and 2:2 row ratio may be attributed to little inter-row competition for light and other growth factors. In 3:3 row ratio systems, the middle row might be disadvantageous for solar radiation penetration. The results are in close conformity with the findings of Shivay and Singh (2000).

Highest dry matter accumulation of maize was recorded with 75 and 100 per cent RDF and both significantly increased the dry matter production over 50 per cent RDF, by 6.2 and 8.9 per cent, respectively on pooled basis.

Further leaf area index and yield attributed of maize were significantly increased up to 75 percent RDF during both the years, however, in pooled basis 7.1 and 8.8 percent increase in LAI was recorded with 75 and 100 percent RDF to the maize, respectively over 50 percent RDF.

Growth parameters and yield attributes of maize was significantly affected by different fertility levels applied to soybean (Table 1). Maximum dry matter accumulation, LAI, cobs/ plant and grains/cob of maize were obtained under 100 and 50 per cent RDF, over no fertilizer application to intercrop. Optimum supply of nutrients to maize might have enhanced meristematic activities in plants by stimulating cell division and elongation of cells which reflected in the increased LAI, which in turn provided greater leaf surface for better inception, absorption and utilization of radiant energy. Similar were the findings of Kapila (1989) and Maurya and Rathi (2000).

Growth and yield attributes

Soybean

Maize and soybean intercropping in 3:3 and 2:2 row ratios showed significant improvement in dry matter accumulation, leaf area index, pods per plant and seeds per pod than 1:1 ratio (Table 2) the lower values with 1:1 ratio might be associated with poor development of plants and lesser accumulation of photosynthetic due to lack of sunlight and shading effect. Such effects of row ratios on yield attributes were also reported by Mondel *et al.* (1998).

Growth parameters and yield attributes of soybean was significantly affected by different fertility levels applied to maize and soybean (Table 2). Maximum dry matter accumulation, LAI, pods/plant and seeds/pod of soybean were under 100 and 50 per cent RDF over no fertilizer application to intercrop and main crop. Kumar and Singh (1992), who also reported such association ship.

Yield

Maize

On pooled basis (Table 3), 16.2 and 12.9 per cent increase in grain yield was observed with 1:1 and 2:2 row ratio, respectively over 3:3 row ratio. The increase is ascribed to the vigorous and enhanced plant growth of maize in 1:1 and 2:2 ratio over 3:3 ratio as a result of reduced inter row specific competition for solar radiation and plant nutrient. Such effects of inter row arrangement on yield of maize have also been reported by Singh and Singh (2001), under maize + legume intercropping system. Application of 100 percent recommended dose of fertility to maize increased the pooled grain yield by 20.9 per cent over 50 per cent RDF. Significant increase in grain yield of maize with increasing levels of fertilizer doses could be attributed to increased dry matter accumulation and dry matter partitioning in crop plant at increasing fertility levels. The 100 and 50 per cent RDF applied to soybean increased the maize grain yield by 16.0 and 12.0 per cent, respectively over no fertilizer application to intercrop soybean. Increased maize grain yield due to increased fertilization to soybean might be associated with increased nitrogen fixation of soybean benefited to the base maize crop. Jat and Gaur (2000) also observed the beneficial effect of soybean intercropping with maize on yield under adequate fertilization to intercrop.

Soybean

On pooled basis (Table 3), 23.5 and 19.2 per

Table 1. Effect of intercropping ratios and fertility levels on dry matter accumulation (g/plant), LAI, cobs per plant and grains per cob of maize

Treatments	Dry matter accumulation (g/plant) at 90 days			Leaf area index at 60 days			Cobs per plant			Grains per cob		
	2003	2004	Pooled	2003	2004	Pooled	2003	2004	Pooled	2003	2004	Pooled
Intercropping ratio												
Maize + soybean (1:1)	179.28	176.23	177.76	3.81	3.58	3.70	1.22	1.2	1.21	252.9	224.4	238.7
Maize + soybean (2:2)	174.23	171.73	171.73	3.74	3.51	3.63	1.22	1.17	1.2	247.2	218.7	232.9
Maize + soybean (3:3)	162.39	161.1	161.75	3.50	3.21	3.35	1.17	1.14	1.16	230.5	201.4	215.9
CD (P=0.05)	6.64	5.99	4.42	0.14	0.16	0.10	NS	NS	NS	12.3	14.8	9.48
Fertility levels (maize)												
100% RDF	178.37	175.86	177.12	3.78	3.56	3.67	1.25	1.21	1.23	255.4	225.5	240.04
75% RDF	173.67	171.86	172.77	3.73	3.51	3.62	1.21	1.18	1.20	248.9	219	234.00
50% RDF	163.85	161.34	162.6	3.54	3.23	3.39	1.15	1.12	1.14	226.3	200	213.1
CD (P=0.05)	6.64	5.99	4.42	0.14	0.16	0.10	0.06	0.05	0.04	12.3	14.8	9.48
Fertility levels (soybean)												
100% RDF	171.95	175.59	176.77	3.79	3.58	3.69	1.28	1.23	1.25	255.9	226.2	241.1
50% RDF	173.74	171.49	172.62	3.72	3.52	3.62	1.23	1.19	1.21	249.8	220	234.9
No fertilizer	164.20	161.98	163.09	3.54	3.20	3.37	1.10	1.09	1.1	224.9	128.3	211.6
CD (P=0.05)	6.64	5.99	4.42	0.14	0.16	0.10	0.06	0.05	0.04	12.3	14.8	9.48
Sole v/s rest												
Sole crop	197.07	191.63	194.35	4.15	4.00	4.08	1.27	1.2	1.24	275	250	262.5
Inter crop	171.96	169.69	170.83	3.68	3.43	3.56	1.20	1.17	1.19	243.5	214.8	229.2
F-Test	S	S	S	S	S	S	NS	NS	NS	S	S	S

Table 2. Effect of intercropping ratios and fertility levels on dry matter matter accumulation (g/plant) LAI, pods per plant and seeds per pod of soybean

Treatments	Dry matter accumulation (g/plant) at 90 days			Leaf area index at 60 days			Pods per plant			Seeds per pod		
	2003	2004	Pooled	2003	2004	Pooled	2003	2004	Pooled	2003	2004	Pooled
Intercropping ratio												
Maize + soybean (1:1)	25.85	24.04	24.95	2.472	2.374	2.423	33.63	27.96	30.8	2.12	2.12	2.12
Maize + soybean (2:2)	28.24	26.11	27.18	2.735	2.652	2.694	36.7	30.41	33.56	2.29	2.26	2.28
Maize + soybean (3:3)	29.53	27.17	28.35	2.799	2.694	2.747	37.81	31.74	34.78	2.33	2.27	2.30
CD (P=0.05)	1.48	1.38	1.00	0.132	0.138	0.095	2.37	1.93	1.51	0.10	0.08	0.08
Fertility levels (maize)												
100% RDF	29.33	27.05	28.19	2.778	2.675	2.727	37.74	31.3	34.52	2.33	2.28	2.31
75% RDF	28.26	26.14	27.2	2.703	2.621	2.662	36.89	30.67	33.78	2.30	2.26	2.28
50% RDF	26.04	24.13	25.09	2.525	2.424	2.475	33.52	28.15	30.84	2.13	2.11	2.12
CD (P=0.05)	1.48	1.38	1.00	0.132	0.138	0.095	2.37	1.93	1.51	0.10	0.08	0.08
Fertility levels (soybean)												
100% RDF	29.82	27.54	28.68	2.804	2.708	2.756	38.63	32.07	35.35	2.33	2.32	2.33
50% RDF	28.52	26.71	27.62	2.717	2.633	2.675	36.93	30.85	33.89	2.30	2.26	2.28
No fertilizer	25.28	23.07	24.18	2.485	2.379	2.432	52.59	27.19	29.89	2.11	2.06	2.09
CD (P=0.05)	1.48	1.38	1.00	0.132	0.138	0.095	2.37	1.93	1.51	0.10	0.08	0.08
Sole v/s rest												
Sole crop	36.77	35.43	36.1	3.247	3.193	3.22	43.00	35.67	39.34	2.53	2.47	2.50
Inter crop	27.88	25.77	26.83	2.669	2.573	2.621	35.05	30.4	33.05	2.25	2.21	2.23
F-Test	S	S	S	S	S	S	S	S	S	S	S	S

Table 3. Effect of row ratios and fertility levels on yields and B:C ratio (pooled data of two years)

Treatments	Maize grain (q/ha)	Soybean seed (q/ha)	Maize equivalent yield (q/ha)	Net return (Rs/ha)	B:C ratio
Intercropping ratio					
Maize + soybean (1:1)	44.44	6.03	60.98	37958.40	3.33
Maize + soybean (2:2)	43.21	7.19	62.94	39147.30	3.43
Maize + soybean (3:3)	38.24	7.45	58.70	35742.60	3.13
CD (P=0.05)	1.48	0.32	1.91	1381.00	0.12
Fertility levels (maize)					
100% RDF	45.08	7.35	65.27	40575.9	3.45
75% RDF	43.54	7.02	62.81	39116.6	3.43
50% RDF	37.26	6.29	54.55	33156.3	3.01
CD (P=0.05)	1.48	0.32	1.91	1381.00	0.12
Fertility levels (soybean)					
100% RDF	44.53	7.35	64.70	40017.3	3.33
50% RDF	43.00	7.06	62.39	38802.1	3.40
No fertilizer	38.36	6.26	55.55	34029.1	3.16
CD (P=0.05)	1.48	0.32	1.91	1381.00	0.12
Sole v/s rest					
Sole maize	51.53	-	51.52	32940.70	3.29
Intercropped maize	41.96	-	60.88	36116.20	3.30
CD (P=0.05)	4.44	-	5.74	4452.80	0.36
Sole soybean	-	17.64	48.63	24447.30	2.50
Intercropped soybean	-	6.89	60.88	37616.20	3.30
CD (P=0.05)	-	0.88	5.74	4452.80	0.36

cent increase in seed yield of soybean was recorded with 3:3 and 2:2 ratio, respectively over 1:1 ratio. Significantly increased seed of soybean in 3:3 ratio seems to be the cumulative effect of increased growth, nutrient uptake and dry matter accumulation as a result of minimum shedding effect of maize under these row ratio of maize+soybean. Mondel *et al.* (1998) also observed highest soybean yield with 3:3 rows of soybean in paired row of maize. On pooled basis, 11.6 and 16.8 per cent increase in seed yield was observed with 75 and 100 per cent RDF to the main crop, respectively, over 50 per cent RDF. Further, 12.7 and 17.4 per cent increase in soybean seed yield was recorded with 50 and 100 per cent RDF, respectively, over no fertilizer application.

Marked improvement in yield of soybean due to increasing levels of fertilizer in main and intercrop could be attributed to over all improvement in plant growth and yield attributes as a result of greater availability of plant nutrient and photosynthetic and metabolites from the source. Kapila (1989) also reported increased seed yield with concomitant improvement in yield attributes and plant growth as a result of adequate supply of plant nutrients to both the crop in intercropping system.

Maize equivalent yield

Examination of data (Table 3) show that highest pooled maize equivalent yield was recorded under 2:2 row ratio which was 3.2 and 7.2 per cent higher over 1:1 and 3:3 row ratio, respectively. Shivay *et al.* (2001) also recorded maximum maize equivalent yield with maize + soybean (45/90) paired planting. Maize equivalent yield increased significantly up to 100 per cent RDF to maize and soybean. Application of 75 and 100 per cent RDF to maize increased pooled MEY by 15.1 and 19.6 per cent, respectively over 50 per cent PDF. Application of fertilizer to component soybean also affected the MEY favorably as compare to no fertilizer, 50 and 100 per cent RDF to soybean increased the MEY by 12.3 and 16.4 per cent, respectively.

Economics

The pooled data (Table 3) show that 3.1 and 9.5 per cent increase in net returns and 3.0 and 9.5 per cent increase in B:C ratio was observed over 1:1 and 3:3 ratio at 2:2, respectively. An improvement in economic indices in 2:2 inter row system was mainly due to higher yield of maize and soybean under study. Panday *et al.* (1999) also reported higher net return with paired planting of maize and soybean in intercropping system. Further, on pooled basis 17.9 and 22.3 per cent higher net returns and 13.9 and 14.5 per cent higher B:C ratio was recorded with 75 and 100 percent RDF, respectively over 50 per cent RDF to maize. On pooled basis 14.0 and 17.5 per cent increase in net returns and 7.5 and 5.3 per cent increase in B:C ratio were observed with 50 and 100 per cent RDF, respectively as compared to no fertilizer application to intercrop soybean. Significant increase in economic indices *viz.*, net returns and B:C ratio due to increasing levels of fertilizers to main and intercrop appear to be the result of increased productivity of both maize and soybean with increasing levels of fertilizer.

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EFFECT OF COMPACTION AND NUTRIENT LEVELS ON CONTENT AND UPTAKE OF SECONDARY NUTRIENTS IN WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

A field experiment was conducted during *rabi* season of 2000 and 2001 with Raj 3077 wheat cultivar. The experiment was laid out in split plot design consisting four levels of compaction (control, 4, 8 and 12 passing of 500 kg manually driven roller) as main plot treatments, three levels of nitrogen (40, 80 and 120 kg N/ha) and three levels of potassium (20, 40 and 60 kg K_2O/ha) as sub plot treatments. Maximum N, P and K content and uptake were obtained under twelve passing of 500 kg iron roller as compared to no passing. Increasing levels of nitrogen and potassium (120 kg N and 60 kg K_2O/ha) also increased the content and uptake of Ca, Mg and S in wheat crop as compared to 40 kg N and 20 kg K_2O/ha , respectively.

Key words : Wheat, compaction, nutrition, nutrient uptake.

In arid and semi-arid parts of India, sandy soils widely occur. These soils are characterized by their coarse texture, looseness, extreme permeability and low organic matter. The moisture retentive capacity of these soils is also very low and are prone to losses of soluble nutrients (Mann and Singh, 1977). Compaction at optimum moisture content of these soils creates a barrier of relatively high bulk density. Compaction of sandy soils is suggested for minimizing percolation losses of nutrients and to improve moisture storage in the soils. Ghildyal and Satyanarayana (1965) explored the possibility of increasing micro pores at the expense of macro pores by soil compaction. Increase in bulk density and moisture retention in surface soil and consequent reduction in hydraulic conductivity at higher compaction level was observed (Kar, *et al.,* 1986). Compaction of sandy soil is a convenient and economic method of decreasing permeability and nutrient loss. The investigation was therefore, undertaken to explore the possibility of efficient utilization of nutrients under present set of soil conditions.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 2000 and 2001 at Agronomy Farm, SKN College of Agriculture, Jobner with Raj 3077 wheat cultivar. The experiment was laid out in split plot design consisting four levels of compaction (control, 4, 8 and 12 passing of 500 kg manually driven roller) as main plot treatments and three levels of nitrogen (40, 80 and 120 kg N/ha through urea) and three levels of potassium (20, 40 and 60 kg K_2O/ha) through muriate of potash) as sub-plot treatment resulting in 36 treatment combinations which were replicated four times. The variance ratio was calculated by Fisher (1950) variance technique. Plant analysis of calcium and magnesium was done as per the techniques suggested by Richards (1954) and sulphur by Tabatabai and Bremner (1970).

RESULTS AND DISCUSSION

Calcium content and uptake

The maximum Ca content was recorded with twelve passing (C_{12}) and minimum under no passing (C_0). The corresponding increase of Ca content in grain was 3.29, 6.33 and 7.85 per cent and in straw it was 1.32, 1.99 and 3.31 per

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Table 1. Effect of compaction, nitrogen and potassium levels on content and uptake of Ca, Mg and S in wheat

Treatment	Ca content (%)		Ca uptake (kg/ha)		Mg content (%)		Mg uptake (kg/ha)		S content (%)		S uptake (kg/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Compaction												
C_0	0.395	0.151	9.728	5.304	0.1120	0.0699	2.752	2.442	0.333	0.0895	8.177	3.126
C_4	0.408	0.153	10.869	6.381	0.1124	0.0706	2.989	2.944	0.339	0.0911	9.009	3.767
C_8	0.420	0.154	12.513	7.146	0.1128	0.0708	3.350	3.264	0.342	0.0914	10.169	4.204
C_{12}	0.426	0.156	13.869	7.746	0.1136	0.0713	3.686	3.534	0.347	0.0922	11.239	4.570
SEm ±	0.0082	0.0012	0.301	0.101	0.0002	0.0003	0.055	0.038	0.0025	0.0054	0.270	0.090
CD at (5%)	0.0264	0.0039	0.896	0.299	0.0006	0.0009	0.162	0.112	0.008	0.0017	0.804	0.268
Nitrogen												
N_{40}	0.396	0.151	8.033	4.788	0.1112	0.0694	2.252	2.177	0.325	0.0893	6.594	2.797
N_{80}	0.408	0.154	11.907	4.788	0.1128	0.0706	3.291	3.172	0.338	0.0908	9.840	4.081
N_{120}	0.434	0.157	15.461	8.275	0.1141	0.0721	4.052	3.796	0.358	0.0928	12.706	4.893
SEm ±	0.0043	0.0008	0.143	0.062	0.0003	0.0003	0.042	0.027	0.002	0.0006	0.122	0.046
CD at (5%)	0.0121	0.0023	0.396	0.171	0.0007	0.00063	0.116	0.076	0.0055	0.0016	0.338	0.129
Potassium												
K_{20}	0.396	0.151	9.627	5.686	0.1121	0.0696	2.719	2.629	0.33	0.0879	7.999	3.297
K_{40}	0.417	0.154	11.773	6.639	0.1126	0.0705	3.177	3.035	0.341	0.0910	9.728	3.823
K_{60}	0.426	0.157	13.831	7.542	0.1134	0.0716	3.680	3.452	0.349	0.0942	11.386	4.533
SEm ±	0.0043	0.0008	0.143	0.062	0.0003	0.0003	0.442	0.027	0.002	0.0006	0.122	0.046
CD at (5%)	0.0121	0.0023	0.396	0.171	0.0007	0.0006	0.116	0.076	0.0055	0.0016	0.338	0.129

cent due to C_4, C_8 and C_{12} treatment, respectively as compared to control. The data indicated that the nitrogen levels also increased the Ca content of grain and straw and the corresponding increase was 3.03 and 3.59 per cent in grain and 1.98 and 3.97 per cent in straw due to 80 kg and 120 kg N/ha, respectively as compared 40 kg N/ha. Similarly, potassium levels also increased the Ca content of grain and straw of wheat. Maximum Ca content was obtained due to 60 kg K_2O/ha and minimum under 20 kg K_2O/ha treatment (Table 1).

The compaction had significant effect on Ca uptake in grain and straw of wheat. Maximum Ca uptake was obtained under twelve passing of 500 kg iron roller (C_{12}) and minimum under no passing (C_0). Increase in uptake of Ca in grain and straw with increasing levels of nitrogen and potassium was observed. Similar findings are reported by Satyanarayana and Ghildyal (1970), Ruzyczka *et al.* (1991) and Sharma and Kumar, (1971).

Magnesium content and uptake

The maximum Mg content was recorded with twelve passing (C_{12}) and minimum under no passing (C_0). The corresponding increase of Mg content in grain was 0.31, 0.67 and 1.38 per cent and in straw it was 1.43, 1.79 and 2.00 per cent due to C_4, C_8 and C_{12} treatment, respectively as compared to control. The data indicated that the nitrogen levels also increased the Mg content of grain and straw and the corresponding increase was 1.48 and 2.65 per cent in grain and 2.01 and 3.67 per cent in straw due to 80 kg N/ha, respectively as compared 40 kg N/ha. Similarly, potassium levels also increased the Mg content of grain and straw of wheat. Maximum Mg content was obtained due to 60 kg K_2O/ha and minimum under 20 kg K_2O/ha treatment.

The maximum Mg uptake were obtained under twelve passing of 500 kg iron roller (C_{12}) and minimum under no passing. The increase in levels of nitrogen and potassium increased the Mg uptake of grain and straw significantly. Increase in uptake following compaction could be attributed to decreased leaching of these nutrients in compacted soils as was also reported by Satyanarayana and Ghidyal (1970). Compaction checks the leaching losses owing to high bulk density in sub-surface soil, which in turn increases Mg absorptin. The significant increase in Mg content and uptake (Sharma and Kumar, 1971). The significant increase in Mg uptake by crop with increase in rate of K application could be due to combined effect of high dry matter yield along with higher K content in straw.

Sulphur content and uptake

The increasing levels of compaction increased the S content of grain and straw. The C_4, C_8 and C_{12} levels of passing increased the S content by 1.80, 2.70 and 4.20 per cent in grain and 1.79, 2.12 and 3.02 per cent, respectively in straw as compared to no passing. Similarly, the increasing levels of nitrogen and potassium also increased the S content of grain and straw of wheat.

The maximum S uptake were obtained under C_{12} and minimum under no passing. In case of nitrogen and potassium application the maximum S uptake were obtained under treatment receiving 120 kg/ha and 60 kg K_2o/ha and minimum under 40 kg N/ha and 20 kg K_2O/ha. Similar results were also reported by Satyanarayana and Ghildyal (1970).

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IMPACT OF IMPROVED TECHNOLOGY ON PRODUCTIVITY OF GROUNDNUT (*ARACHIS HYPOGAEA* L.) UNDER FIELD CONDITIONS

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ABSTRACT

Front line demonstrations were conducted during 2004-2005 at the farmers field by various Krishi Vigyan Kendras in Karnataka and Tamil Nadu to demonstrate the impact of various components of groundnut based production technologies *viz.* improved varieties, integrated nutrient management, integrated pest management, integrated disease management, integrated weed management, intercropping along with whole package of production technology on the productivity of groundnut under field conditions GPBD-4 variety recorded highest pod yield (2010 kg/ha) which was 74.78% more than the local variety. The average increase in pod yield due to other components was 56.03, 43.17, 27.60, 39.39, 21.21 and 52.30%, respectively over the farmers practice. The maximum average pod yield (1878 kg/ha) was obtained due to adoption of improved varieties. The highest net returns (80.53%) was obtained due to adoption of recommended integrated nutrient management.

Key words : Frontline demonstration, groundnut, KVK.

To fulfill present edible oil requirement of the burgeoning population, there is a need to enhance the production of oilseeds in our country. Groundnut is the principal oilseed crop in India. It is grown in 11 states of India in an area of 7.6 million hectare with a production of 7.8 million tones of pods per annum (FAO, 2001). Edible oil situation mainly depends on the groundnut production. In order to achieve self sufficiency in edible and non edible oil in a shortest possible period, the Government of India initiated Technology Mission on Oilseeds and Pulses (TMOP, 1986) on first May, 1986. After 20 years of implementation of TMOP, there is a significant improvement in the oilseeds production in our country where the production has been increased from 10.83 million tones in 1986 to 25.14 million tones in 2003 - 05 (Anonymous, 2004). However, the average productivity of groundnut is much low (756 kg/ hectare). Non-adoption of improved varieties, biofertizer, integrated nutrient, pest and weed management are the main reasons for low production in most groundnut growing region.

Realising the importance of strong support system to the farmers though transfer of technology, Government of India initiated a centrally sponsored oilseed production programme (Opp, 1990) in 1990, in which front line demonstrate was the main component. The main objective of front line demonstration is to demonstrate the production potentialities of the newly developed crop production technologies of oilseeds recommended for different agro-ecological crop growing situations vis-à-vis prevailing forming practices (Hegde *et al.*, 1998). This programme is going on through the extensive network of Krishi Vigyan Kendras in various states. There are 73 KVKs in Zone VIII covering Karnataka, Kerala, Tamil Nadu, Goa, Pondicherry and Lakshadweep. This attempt is made to study the impact of improved technology on productivity of groundnut under field conditions.

Objective :

1. T create awareness and interest among the farmers about the new production technologies of groundnut under the existing farming system.
2. To motivate farmers by demonstrating the potential of improved technologies for

adoption in their fields.

3. To provide feed back to research and extension system.

MATERIALS AND METHODS

The front line demonstrations were conducted by various Krishi Vigyan Kendras during 2004 -05 under the close supervision of the scientists of the National Agricultural Research System. Suitable soils for groundnut production were selected for demonstrations and soil samples were analysed. Survey were conducted in the farmers field to know the production constraints faced by the farmers. The components were used as per the recommendations for various regions. While conducting the demonstrations, following points were taken into consideration :

1. The demonstrations were conducted in a minimum area of 1.0 hectrare and maximum of 5.0 hectare.
2. Only new released varieties and technologies were used in the demonstrations. Local check yield data were also collected from the same farmers field, in the same location.
3. The demonstrations were conducted with the active involvement of the farmers and scientists monitored various field activities like sowing, fertilizer application and plant protection etc. with their presence.
4. All the relevant observations and data concerned to those demonstrations were systematically recorded.

RESULT AND DISCUSSION

Improved variety

It is evident from Table that improved variety is increased pod yield by 41.45% over the local varieties. GPBD-4 variety recorded highest increase in pod yield by 74.78% over local variety in Mysore. The lowest increase of 21.95% was recorded by TMV-2 variety over local variety in Mangalore district.

Integrated Nutrient Management (INM)

Table 1 revealed that integrated nutrient management practice recorded 56.03% increase in pod yield over farmers practice. The highest increase in pod yield of 67.79% at Cuddalore and lowest of 47.05% was recorded due to integrated nutrient management over the farmers practice.

Integrated Pest Management (UPM)

The results of front line demonstration on integrated pest management showed that there was an increase n the pod yield by 47.213% over farmer's practice of pest management. The highest increase in pod yield of 60.34% and lowest increase of 38.21% was recorded due to IPM technology over the farmer's practice.

Integrated Disease Management (IDM)

The results of 12 demonstrations at two KVKs showed that an average 31.78% increase in pod yield was recorded due to adoption of integrated disease management over farmers practice. The highest increase in pod yield was 34.07% while lowest increase in pod yield was 29.49% over the farmer's practice of disease control.

Intercropping

A total of eight demonstrations were conducted with three intercropping system namely groundnut + pigeonpea, groundnut + maize and groundnut + sunflower. On in average groundnut yield equivalent was increased by 39.39% over farmer's practice of sole groundnut.

Improved Package of Practice

The results of demonstration on improved package of practice revealed that an increase of 52.3% in pod yield was recorded due to improved package of practices over the farmers traditional practice.

Integrated Weed Management (NWM)

Five demonstrations on Integrated Weed Management (IWM) showed that the pre emergence application of Pendimethalin @ 1 kg a.i. per hectare + 1 Hand Weeding + 1

Table 1. Impact of improved technology on the productivity of groundnut during 2004-2005

Variety									
TAG-24	Belgaum	1982	1460	35.75	14180	12906	31406	20674	51.91
GPBD-4	Mysore	2010	1150	74.78	15931	11217	30299	15233	98.90
TMV-2	Mangalore	1640	1280	21.95	14100	12800	23620	16640	41.94
JL-24	Kancheepuram	1830	1300	40.76	14954	13400	27136	16500	64.46
VRI-5	Thanjavur	1930	1440	34.02	14566	12954	29824	20166	47.89
Average	1878	1326	41.45	14746	12655	28457	17842		61.02
Integrated Nutrient									
	Belgaum	1870	1220	53.27	14200	12122	28810	15938	80.76
	Coimbatore	1750	1190	47.05	15073	12452	25177	14918	68.76
	Cuddalore	1980	1180	67.79	14835	11156	30705	15984	92.09
	Average	1866	1196	56.03	14702	11910	28230	15613	80.53
Integrated Pest Management	Haveri	1890	1350	40.00	15295	13105	28175	17945	57.00
	Cuddalore	1860	1160	60.34	14823	12117	27957	14563	91.97
	Bellary	1700	1230	38.21	15040	13972	24060	14318	68.04
	Perambalur	1880	1250	50.40	14566	12954	28674	15796	81.52
	Average	1832	1247	47.23	14931	13037	27216	15655	74.63
Integrated Disease									
	Belgaum	1800	1390	29.49	13884	10893	27516	21077	30.54
	Erode	1810	1350	34.07	13027	12383	28603	18667	53.22
	Average	1805	1370	31.78	13455	11638	28059	19872	41.88
Package of Practices									
	Gadag	1980	1300	52.30	13893	11996	31647	17904	76.75
Intercropping									
	Bijapur	1610	1132	42.22	13985	10102	23045	15934	44.62
	Dharwad	1630	1150	41.73	12800	12100	24690	14350	72.05
	Gadag	1580	1130	34.24	13056	11812	25990	14178	83.31
	Average	1606	1137	39.39	13280	11338	24575	14820	66.66
Integrated Weed Management	Thanjavur	1600	1320	21.21	12525	10680	30360	19680	54.26

Intercultural at 25-30 days sowing controlled the weed effectively and the increase in pod yield was 21.21% in IWM plots compared to non IWM plots.

Economics

1. The cost of cultivation ranged from Rs. 12525 to Rs. 15931 per hectare for improved practice as compared to Rs. 10102 to Rs. 13972 per hectare for farmer's practice.
2. The adoption of all improved cultivars increased net return to farmers. On an average, an increase in net monetary returns of 61.02% over farmers variety was observed. The explicity show that improved variety was highly profitable over the local variety.
3. The highest net return of 80.53% was obtained due to adoption of recommended integrated nutrient management schedule over the farmers' practice.
4. The integrated pest management increased net returns by 74.63% over farmer's practice of pest management.
5. The adoption of integrated disease management increased the net returns by 71.88% over the farmers practice of disease control.
6. The adoption of groundnut intercropping increased net returns by 66.66% as compared to sole groundnut.
7. The integration of all the recommended components in form of improved package of practices increased the net returns by 76.75% over farmers practice.
8. Integrated weed management increased the net returns by 54.26% compared to farmers practice mainly due to increase in yield.

Impact assessment

Impact assessment revealed that after intervention there has been an increase of 98% in the area and 50% in the production of groundnut crop. Enquiries were made about the technological aspect of groundnut cultivation. It was revealed that farmers have adopted the high yielding varieties, using balanced use of fertilizers and plant protection measures.

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EFFECT OF ORGANIC FERTILIZERS ON YIELD AND YIELD ATTRIBUTING TRAITS OF DIRECT SOWN RAINFED FINGER MILLET (*ELEUSINE CORACANA* L. GAERTN.)

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Abstract

A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during *kharif* season of 2003 to study the effect of organic sources in direct sown rainfed finger millet. The growth attributes *viz.*, plant height, leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR), dry matter production (DMP) and number of tillers per m^2 were significantly influenced by the application of 12.5 t FYM/ha in the finger millet + pigeonpea intercropping at row ratio of 6:2 followed by the application of recommended doses of NPK. Significant increase in yield components *viz.*, number of fingers per ear head and thousand (1000) grain weight were noticed in the finger millet + pigeonpea intercropping at row ratio of 6:2 + 12.5 t FYM/ha treatment. This was closely followed by the application of recommended NPK treatment. With respect to grain and straw yield, higher grain yield (2963 kg/ha) and straw yield (6030 kg/ha) of finger millet were obtained under finger millet + pigeonpea intercropping at 6:2 row ratio + 12.5 t FYM/ha treatment.

Key words : Finger millet, organic manure, green manure, azospirillum, phosphobacterium.

Ragi or mandua commonly known as finger millet (*Eleusine coracana* L. Gaertn.) is an important small millet crop grown in India. It is a staple food crop in many hilly regions of the country. The crop is well adapted to very poor and marginal uplands, where other *kharif* crops cannot be grown successfully.

Finger millet is one of the best suited cereal for preparing weaning food due to presence of high quality protein and availability of amino acids. It is also rich in calcium (overcomes bone and teeth disorders), iron (reduces anaemia occurrence) and phosphorus (bone development). Usage of finger millet as a staple food is fast increasing due to the increase in people suffering from *Diabetes melitus.*

With chemical fertilization alone the soil systems would degrade. Therefore, augmenting soil resources in finger millet cropping system is a must. This has to be done with those forms of nutrients in such a way that the crop should fully utilize the energy. The full utilization also depends on the genetic potential of the variety and this combined with efficient management practices that encourage more food production of land which in turn would further reduce the exploitation of fragile soil crop production system. Hence, the present study is under taken to optimize the farmyard manure requirement of rainfed direct sown finger millet in conjugation with green manuring crops *viz.*, cowpea and soybean and bio fertilizers. As the organic farming practices are planned to suit the farmers, an investigation was carried out to study the effect of organic sources on growth ad yield of direct sown rainfed finger millet.

Materials and Methods

Field experiment was conducted during *kharif* season of 2003 at Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore to develop an effective organic farming practice for direct sown finger millet under rainfed conditions. The soil of the experimental field was medium deep black and clay loam in texture classified taxonomically as Typic haplustalf. The soil was low in available nitrogen (238 kg/ha), medium in available phosphorus (12.2 kg/ha) and high in available potassium (370 kg/ha).

The experiment was laid out in a randomized block design (RBD) with three

Table 1. Effect of organic fertilizers on yield and yield attributing traits of direct sown rainfed finger millet

Treatments	Plant height (cm)	Leaf area index	Crop growth (gm^{-2} day^{-1})	Relative growth rate (gg^{-1} day^{-1})	Drymatter production (kg/ha)	Number of tillers per m^2	Number of fingers/ ear head	1000 grain weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
Finger millet supplied with only 12.5 t FYM/ha	123.7	3.44	2.92	8.20	3993	170	6.60	2.76	2707	5832
Finger millet supplied with 7.5 t FYM/ha + rock phosphate @ 20 kg/ha	112.3	2.69	2.17	7.32	3563	156	6.10	2.72	2211	5519
Finger millet supplied with 7.5 t FYM/ha + biofertilizer (seed and soil inoculation)	113.6	2.94	2.42	7.58	3690	159	6.33	2.74	2411	5647
Finger millet + soybean intercropping at row ratio of 2:1 (incorporation of soybean as green manure) and application of 7.5 t FYM/ha	112.5	2.57	1.93	7.05	3270	150	5.86	2.71	2151	5422
Finger millet + cowpea intercropping at row ratio of 2:1 (incorporation of cowpea as green manure) and application of 7.5 t FYM/ha	109.4	2.51	1.72	6.69	3096	151	5.40	2.70	2005	5366

Table 1. cond.

Finger millet + pigeonpea intercropping at row ratio of 6:2 + 12.5 t FYM/ha	124.9	3.98	3.64	8.46	4463	182	6.93	2.84	2963	6030
Finger millet supplied with only recommended NPK of 40:20:20 kg/ha	124.1	3.65	3.11	8.23	4115	176	6.80	2.80	3000	6146
Finger millet supplied with 7.5 t FYM/ha + biofertilizer (seed+soil inoculation)+rock phosphate	116.0	3.25	2.63	7.81	3783	164	6.46	2.73	2605	5691
Absolute control	95.9	1.91	0.95	5.72	2926	140	5.13	2.66	846	2458
C.D. (P=0.05)	12.55	0.06	0.43	1.49	216.60	4.90	0.90	0.09	125	182

replications. All the nine treatment combinations were allotted at random to plots within each replication. Finger millet, Co 13, the ruling medium duration variety of this area was chosen as the base crop. It is obtained by crossing Co 7 and TAH 107. It is a popular high yielding variety, nitrogen responsive and non-lodging strain with a duration of 105 to 110 days. A medium duration variety Co 5) of pigeonpea was selected as an intercrop at 6:2 row ratio. The seed rates adopted were 5 kg/ha for finger millet and 5 to 6 kg/ha for pigeonpea (as inter crop). The spacing maintained was 30 cm between rows and 10 cm between plant to plant. Required quantities of FYM as per the treatment schedule at the time of sowing and cowpea (*Vigna sinensis*) and soybean (*Glycine max*) on 45th day after sowing were incorporated into the soil. *Azospirillum* and *phosphobacterium* were used for seed and soil inoculation @ 25 g/kg pf seeds and 1 kg per 25 kg of soil, respectively for one hectare land. Urea (analyzing 46 per cent N) @ 40 kg/ha was applied to supply various quantities of nitrogen as a basal dose. Phosphorus as single super phosphate (analyzing 16 per cent water soluble P_2O_5) and potassium as muriate of potash (60 per cent K_2O) each @ 20 kg/ha were also applied as basal dose. Nitrogen was supplied through organic sources as per the treatment.

RESULTS AND DISCUSSION

The plant height increased with the advancement of crop growth stages and it was highest as harvest. Appreciable increase in finger millet height was recorded under finger millet + pigeonpea intercropping at row ratio of 6:2 + 12 t FYM/ha treatment. This may be attributed to the early vigorous growth of pigeonpea, constantly caused shading to finger millet, which resulted in the etiolation of finger millet stem. This confirms the opinion of Stickler and Younis (1961) indicated that under limited light, elongation of internode is a common plant response. With reference to leaf area index (LAI), finger millet + pigeonpea intercropping at row ratio of 6:2 + 12.5 t FYM/ha recorded higher value. Increase in pant height as well as number of tillers might be the reason for increased leaf area index.

The enhanced effect of organic manure on crop growth rate (CGR) and relative growth rate (RGR) under finger millet + pigeonpea intercropping at row ratio of 6:2 + 12.5 t FYM/ha might be due to steady and higher N availability through organic manures by the enhanced activity of beneficial microbes like N_2 fixers.

Finger millet + pigeonpea intercropping at row ratio of 6:2 + 12.5 t FYM/ha showed high dry matter production as compared to all other treatments. It might be due to more plant eight, number of tillers and leaf area index. Incorporation of soybean and cowpea showed low dry matter production. It might be due to slow decomposition of these incorporated green manuring crops, consequently slow release of nutrients and hereby reduction in dry matter. Subramanian and Kumaraswamy (1989) reported that dry matter production of finger millet increased with organic manure application at active tillering and flowering stages. Number of tillers per m^2 were influenced greatly in the finger millet + pigeonpea intercropping at row ratio of 6:2 + 12.5 t FYM/ha. The reason attributed due to easy availability of nutrients to the crop plants because of addition of well decomposed FYM at higher quantity.

Number of fingers per ear head was reported under finger millet + pigeonpea intercropping at row ratio of 6:2 + 12.5 t FYM/ha. It might be attributed due to the fact that FYM supplies both marco and micro nutrients in readily available form which interact with native soil nutrients in such a way that enhances their availability to crops. Mani (1991) reported increased finger number per ear head with FYM application. The marked reduction in number of fingers per ear head was recorded in the soybean and cowpea incorporated plots. This was due to non-availability of nutrients to the crop at critical growth period because decomposition of these crops taken longer time to supply nutrients in time to succeeding crop. Finger millet + pigeonpea intercropping at row ratio of 6:2 + 12.5 t FYM/ha significantly showed higher value of thousand grain weight as compared to other treatments. It might be due to the well fulfilled grains or better translocation of photosynthates from source to sink. Similar findings were also reported earlier by Singh and Singh (1969).

The grain and straw yield of finger millet increased with the application of FYM at higher level. Increased grain (28.20 per cent) and straw (39.9 per cent) yield were obtained under recommended NPK treatment which was followed by finger millet + pigeonpea intercropping at row ratio of 6:2 + 12.5 t FYM/ha and in the treatment in which only 12.5 t FYM/ha had applied. Increase in grain yield with FYM application was closely associated with the significant differences in yield components such as higher productive tillers per m^2, number of fingers per head and 1000 grain weight. Doraiswamy *et al.* (1989) and Mani (1991) also obtained similar results in finger millet.

Lowest grain and straw yield were recorded in absolute control. This was quite natural that the inherent soil available nutrients were not sufficient to meet the crop demand under the treatment.

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EFFECT OF GREEN MANURING AND NITROGEN LEVELS ON YIELD AND NUTRIENT UPTAKE BY RICE

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Abstract

Field experiments were conducted during 2001 and 2002 to study the effect of green manure, grain legume and their combination on succeeding rice with graded N levels. Two-grain legumes and two green manures were used for the study. The haulms of grain legume after harvest of pods and biomass of green manure were incorporated. The succeeding rice crop was raised in *kharif* season in split plot design with three N levels in the subplot. The N, P and K. uptake and grain yield of rice crop was significantly higher with the application of green manure *Sesbania aculeate*. Combined application of grain legume and *S. aculeate* was the next best.

Key words : Rice, green manuing, N lvels, yield.

Green manures seem to be an attractive alternate source to meet a substantial portion of the rice N requirement and provide organic matter to wetland rice soils. Addition of organic sources could increase yield through increased soil productivity and higher fertilizer use efficiency (Santhi and Selvakumari, 2000). In the present investigation inclusion of green manure and grain legume crop before rice was made to evaluate the potential to supply the nutrients in combination with inorganic fertilizers.

Materials and Methods

Field experiments were conducted at Agricultural College and Research Institute, Madurai from 2001 to 2002. The soil was sandy clay loam in texture with low available N, medium available P and green manures were raised in summer season. Two-grain legumes (green gram and cowpea) and two green manures (*S. aculeate* and *Phaseolus trilobus*) were used for the study. Their performance was assessed both in sole and intercropped stand in summer season before rice crop. The pre rice crops were laid out in RBD and replicated thrice. The haulms of grain legume after harvest of pods and biomass of green manure were incorporated. The succeeding rice crop (var. ADT 36) was raised in *kharif* season in split plot design and replicated thrice with nine treatment combinations of grain legumes and green manures in main plots and three levels of N in the subplots *viz.*, zero N, 50% recommended dose of N (60 kg N) and 100% recommended dose of N (120 kg N). Plant samples were collected from each plot for analyzing N, P and K from rice crop.

Results and Discussion

N uptake

Nitrogen uptake by rice increased with the age of rice crop. At harvest, it ranged from as low as 77.5 kg/ha to as high as 132.5 kg/ha under various treatments in 2001 and from 71.8 to 128.4 kg/ha in 2002. At active tillering stage. Application of *S. aculeate* recorded significantly higher N uptake of 34.0 and 30.6 kg/ha followed by cowpea + S. aculeate and green gram + *S. aculeate*. Application of 100 percent N enhanced the N uptake and recorded 36.3 kg/ha in 2001 ad 32.7 kg/ha in 2002. 50 percent N followed by this, was significantly better than no N application. N uptake was found to be highly related to the levels of N applied. Every increment in the dose of N increased the uptake of N.

Application of 100 percent N caused higher uptake of N at flowering, at harvest over other two levels. Interaction effect was found to be significant. The increased N uptake in rice in

Table 1. Influence of green manuring and N management on nutrient uptake

Treatments	N uptake						P uptake		K uptake		Grain yield	
	Active tillering		Flowering		Maturity		Maturity		Maturity		(kg/ha)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Green manuring												
Cowpea	28.2	24.9	69.9	66.7	105.6	101.2	28.4	24.8	158.5	154.9	4729	4609
Greengram	28.0	25.3	69.2	65.4	101.5	97.5	28.1	24.6	165.7	166.2	4450	4479
Sesbania aculeata	34.0	30.6	81.4	77.5	132.5	128.4	40.7	36.5	187.7	180.4	5810	5652
Phaseolus trilobus	29.4	25.8	71.2	67.5	109.3	104.4	30.4	26.5	170.3	167.5	4832	4603
Cowpea + S. aculeata	32.0	28.7	74.7	72.0	122.7	118.2	37.5	34.3	178.3	175.5	5297	5168
Cowpea + P. trilobus	30.1	26.6	71.0	67.9	113.4	107.3	31.5	28.0	172.8	169.5	5017	4899
Greengram + S. aculeata	31.2	27.5	73.9	71.3	120.8	116.0	34.6	31.1	173.5	172.6	5207	5014
Greengram + P. trilobus	30.7	26.4	72.0	68.8	110.9	105.4	32.3	27.4	169.5	166.4	4982	4816
Control	24.3	20.5	56.1	53.5	77.5	71.8	19.9	17.3	150.0	147.2	3845	3649
SEd ±	0.85	0.92	1.35	1.26	1.15	2.02	1.42	1.36	2.89	1.52	134	128
CD at 5%	1.80	1.96	2.86	2.67	2.43	4.26	3.01	2.75	6.15	3.22	285	273
N levels												
Control	21.9	18.2	61.4	57.9	98.3	92.7	24.8	20.6	155.1	150.22	3925	3861
50% of recommended dose of N	31.1	27.6	72.9	69.7	113.1	107.8	32.7	29.2	174.5	168.4	5158	4947
100% of recommended dose of N	36.3	32.7	78.8	75.9	120.1	116.2	36.9	33.6	181.8	179.2	5673	5477
SEd ±	0.41	0.53	0.67	0.59	0.69	0.86	0.33	0.30	2.05	0.86	84	79
CD at 5%	0.83	1.08	1.35	1.20	1.40	1.73	0.67	0.58	4.36	1.84	169	162

response to green manuring might be due to increased availability of soil N. Much of the photosyntates for sink was derived from the photosynthesis and after flowering (Babu, 1995). Therefore the nutrient uptake during flowering stage is more crucial. More the N uptake during this stage better is the sink accumulation and the yield.

P uptake

P uptake by rice increased with age and at harvest it ranged from as low as 19.9 to as high as 40.7 kg/ha under various treatments in 2001 and 17.3 to 36.5 kg/ha in 2002. Green manure with *S. aculeate* was the next best. Least P uptake was observed in no organics addition. Increasing level of N application increased P uptake compared to no N application. Uptake of P was highest with the application of sole *S. aculeate* and 100 percent N. Increased drymatter production coupled with higher P content of plants enhanced P uptake. The organic acids produced during green manure decomposition could have increased the volatilization of native P, thus leading to better utilization of P from the soil. Increased P and K uptake was mainly associated with increase in dry matter as a result of organic manure application (Bagavathi Ammal and Durairaj Muthiah, 1995).

K uptake

K uptake by rice also increased with age. At harvest the K uptake ranged from as low as 150 to as high as high as 187.7 kg/ha under various treatments in the first year and 147.2 to 18.0.4 kg/ha in the second year. There was an increase in K uptake with the inclusion of *S. aculeate* either alone or in combination with grain legumes. Inclusion of sole *S. aculeate* produced distinct increase in K uptake followed by the combined use of grain legumes and *S. aculeate*. Higher K uptake was observed with increased levels of N application. The interaction effect between organic sources and N levels was significant in both years. Higher K uptake was mainly due to greater drymatter production and K absorption in mannured plots. K absorption was in association with N uptake and in view of this the uptake of K got decreased at reduced dose of fertilizer N (100 to 50 percent). Green manures contributed K and other elements (Bhuiyan *et al.*, 1988). In the absence of green manuring, K uptake was found to be reduced.

Grain yield

Incorporation of preceding leguminous crops with N levels significantly influenced the grain yield of rice in both the years. Increasing N supply through higher levels of fertilizer N application increased the yield. Incorporation of *S. aculeate* recorded significantly higher grain yield of 5810 and 5652 kg/ha in the first and second year, respectively. The marked increase in grain yield with incorporation of *S. aculeate* could be attributed to the enrichment of soil fertility through profused nodulation as well as green biomass addition into the soil. This is in accordance with the findings of Somasundaram *et al.* 1996.

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ACCEPTABILITY AND KEEPING QUALITY OF MILKY MUSHROOM WITH SPECIAL REFERENCE TO ASSAM

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ABSTRACT

The commercial cultivation technology of milky mushroom (*Calocybe indica*) has been standardized and it has now become the third commercially grown mushroom in India next to button and oyster mushrooms. Development of two recipes of milky mushroom, *viz.*, pulao and noodles gave positive results over the same recipes prepared from oyster mushroom. Noodles prepared from milky mushroom scored the highest on a seven point scale for its color, appearance, taste and texture and the product pulao scored the highest for its color and taste. The shelf life of milky mushroom was found extremely high, *i.e.*, 6 days at ambient temperature and up to 8-9 days under refrigerated condition. Storability of the mushroom in nine different humidity levels (RH 11-92%) was also determined by sorption studies using nine chemicals in nine small chambers. Fruit bodies stored in $MgCl_2$ (RH 32%) showed maximum and faster weight loss with slow deterioration and that stored in KNO_3 (RH 92%) showed last weight loss with faster deterioration. During storage, three mold fungi *viz.*, *Aspergillus niger*, *Penicillum* spp. and *Mucor* spp. were isolated from the fruit bodies.

Key words : Milky mushroom, recipes, acceptability, keeping quality, sorption study.

Mushroom are eukaryotic, spore bearing macro-fungi devoid of chlorophyll. Milky mushroom, a tropical edible fungus has become the third commercially grown mushroom in India after button and oyster mushroom. It is being cultivated in Karnataka, Tamil Nadu and Andhra Pradesh in large scale (Jalali *et al.* 2003). The cultivation technology of milky mushroom in Assam has been standardized by Sarmah (2004) and the best growing season of this mushroom has been found to be the summer months starting from May to August. High temperature (28-35°C) and high light intensity (1600-8000 Lux) are most favourable for this mushroom. Vermicompost alone and in combination with moss has been found to be best casing treatments. Unlike other mushrooms, use of this mushroom in the form of pickle and chutney is a new concept due to limited shelf life period governed by high moisture content (90%). As a new introduction of this edible fungus into Assam, peoples' opinion regarding acceptability of milky mushroom and its keeping quality had been evaluated in the present investigation.

MATERIALS AND METHODS

The experiment was carried out in the Department of Plant Pathology, Assam Agricultural University, Jorhat, Assam in collaboration with Department of Food and Nutrition, Faculty of Home Science, AAU during 2003 and 2004. Firstly, cultivation of milky mushroom was done as per the procedure of Marimuthu *et al.* (2002). The fruit bodies were harvested after attaining the optimum growth stage having long stipe with partially opened pileus and used for experiment.

Two recipes, *viz.*, mushroom noodles and mushroom pulao were prepared. Evaluation of taste was done by a panel comprising of seven members and the acceptability was compared with same recipes prepared with oyster mushroom. The ingredients and procedure for preparation of two recipes were as follows:

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Mushroom noodles :
Ingredients

Milky mushroom (fresh)	300 g
Noodles	1 pkt
Raw vegetables (carrot, bean, capsicum, cabbage)	as per requirment
Onion, medium sized	1 no.
Soya sauce, tomato sauce, salt	as per taste
Refined oil	as per requirement

Method

At first, the mushroom, onion and raw vegetables were chopped into small pieces. The noodles were boiled and then it was put in cold water. Oil was heated and the chopped onion and raw vegetables along with the mushroom was fried until half cooked. Then the boiled noodles were added and mixed with vegetables. Soya sauce and tomato sauce were also added.

Mushroom pulao :
Ingredients

Scented rice (Keteki Joha)	250g
Fresh mushroom	400g
Onion, big sized	2 nos.
Cashew, raisin	as per requirement
Cardamom, clove, cinnamon (crushed)	as per requirement
Refined oil	as per requirement
Salt	as per taste

Method

At first, rice was soaked in water for 10-15 minutes The mushrooms and onion were chopped. Soaked rice was taken out from water. The chopped onion and mushroom were fried in refined oil and the spice mixture along with cashew and raisin were added. Then rice was added and fried for a few minutes and after adding water, the lid of the pressure cooker was closed till the rice got cooked. To compare the acceptability of milky mushroom, the same recipes were prepared with oyster mushroom and tested.

Keeping quality of milky mushroom

Freshly harvested mushroom of a known quantity (100g) was put in a paper bag and kept at room temperature (25-28°C). Another packet was kept under refrigerated condition. Observations were made till the samples started browning.

The shelf life was also determined by sorption studies. A humid chamber was prepared by using a desiccator where a definite humidity level was maintained using one specific chemical. Thus, nine humid chambers ranging from 11-92 per cent were created using nine chemicals *viz.*, $LiCl_2$ (RH 11%), CH_3COOK (22%), $MgCl_2$ (32%), K_2CO_3 (44%), NaBr (56%), $NaNO_2$ (64%), NaCl (75%), K_2CrO_4 (86%) and KNO_3 (92%). Ten gram of fresh mushroom sample was placed in each humid chamber. The samples were duplicated and the mean data were taken. The shelf life study was continued until mold growth occurs on the fruit bodies.

RESULTS AND DISCUSSION

Two recipes, namely, mushroom noodles and mushroom pulao were developed for evaluating the acceptability of milky mushroom. In sensory/organoleptic evaluation, the scores given by all judges for each quality attribute were averaged. The mean score for the mushroom recipes is presented in Table 1. Of the two recipes prepared for both milky and oyster mushroom, the product developed from milky mushroom was liked better compared to sample products prepared from oyster mushroom. The products prepared from milky mushroom were liked extremely for its attractive colour and shape which were retained even after cooking. On a seven point scale, the products of milky mushroom noodles scored highest *i.e.*, 7 for its colour, appearance, taste and texture. Present findings were in agreement with Jalali *et al.* (2003) who also concluded that the pickle prepared from milky mushroom scored the highest with 17.6 and 16.2 points on a 30 point scale for its colour, texture, flavour and taste even at zero day of storage and after three months of storage at room temperature. Further, the test panel members not only accepted the milky mushroom

Table 1. Sensory evaluation for mushroom recipes

Variables	Products of milky mushroom		Products of oyster mushroom	
	Noodles	Pulao	Noodles	Pulao
Colour	7	7	6	6
Appearance	7	6	6	5
Taste	7	7	6	6
Flavour	6	6	5	6
Texture	7	6	5	5
Over all acceptability	7	6	5	6

Grades :

Liked extremely	: 7	Disliked slightly	: 3
Liked moderately	: 6	Disliked moderately	: 2
Liked slightly	: 5	Disliked extremely	: 1
Neither liked nor disliked	: 4		

products but also opined that by increasing the amount of mushrooms more than the amount used in the recipes, the products would taste better. This has indicated that the milky mushroom can be popularized in Assam like any other cultivated and wild edible mushroom species because of its unique and acceptable taste.

For determining the keeping quality, freshly harvested fruit bodies measuring 10g was stored at room temperature in paper bag. The fruit bodies were found to remain fresh up to 6 days in its consumable condition (Table 2). Some brown spots appeared from the 7th day onward along with mold growth. In the similar context, Krishnamoorthy (2003) reported that the shelf life of *C. indica* is increasingly high (5-7 days at room temperature) compared to any other cultivated mushrooms. Thus, the study on keeping quality depicts that the milky mushroom even though is very recent origin in commercial field, its prolonged shelf life and consumers acceptability has attracted the people for its cultivation in the tropics (Balakrishnan, 2002). In other study, same amount of fruit bodies, *i.e.*, 100g was kept under refrigerated condition and these fruit bodies remained fresh for 8-9 days in its consumable condition. Small brown to black spots developed from the 10th day onwards which was the sign of deterioration of the fruit bodies leading to inconsumable condition. In contrast, oyster mushroom could be stored in refrigerator for a minimum of 3 days (Marimuthu *et al.* 1989) to 6 days (Gogoi, 2001). During storage condition, various mold fungi were isolated from the fruit bodies. The most commonly isolated ones were *Aspergillus niger*, *Penicillium* spp., *Mucor* spp., etc.

Sorption study of was also carried out at nine levels of humidity using nine chemicals. The loss in weight of the fresh samples at different levels of humidity has been presented in Table 3. The colour change was noticed from 3rd day onwards but without any development of molds and spots. Mold growth appeared as early as on the 4th day at 92% humidity (KNO_3). Sample stored in NaBr, NaCl and K_2CrO_4 showed the appearance of mold growth on the 5th day. Maximum weight of the sample on the 5th day was 2.717g in CH_3COOK (RH 22%) and the lowest weight (0.188 g) was observed in the case of Mg Cl_2 (RH 32%). Thus, the sorption studies revealed that at higher relative humidity, loss in fresh weight of the fruit bodies was minimum while deterioration the mushroom was faster due to quicker mold growth. On the other hand, loss in weight was maximum at relative humidity 32% followed by 44, 11, 64 and 22% RH but the deterioration was slow as compared to that at relative humidity 92%.

In conclusion, the milky mushroom even is of very recent origin, it has got good acceptance

Table 2. Shelf life of milky mushroom at ambient temperature and refrigerator

Sample keeping Condition	Duration of sample storage (in days)									
	1	2	3	4	5	6	7	8	9	10
Room temp. (25-28°C)	G	G	G	G	G	G	*	*	*	*
Refrigerator	G	G	G	G	G	G	G	G	G	*

G : Samples remaining fresh and good condition
* : Mold growth and browning

Table 3. Determination of shelf life of milk mushroom by sorption study

Chemicals (% RH)	Weight of the sample (g)					
	0th day	1st day	2nd day	3rd day	4th day	5th day
$LiCl_2$ (11)	10	8.578	7.469	3.981	2.264	1.885
CH_3COOK (22)	10	8.137	6.498	3.896	3.344	2.717
$MgCl_2$ (32)	10	6.378	4.273	1.218	0.463	0.188
K_2CO_3 (44)	10	6.872	3.799	0.976	0.767	0.266
NaBr (56)	10	8.801	7.386	4.750	3.289	*
$NaNO_2$ (64)	10	8.238	6.006	3.273	2.284	2.156
NaCl (75)	10	9.090	8.160	6.851	5.671	*
K_2CrO_4 (86)	10	6.897	6.088	4.701	4.196	*
KNO_3 (92)	10	9.574	8.955	8.398	*	*

*Mold growth observed

quality for its taste, flavour and colour. However, further attempts are to be made for wide popularization. Another unique advantage of this mushroom is its shelf life which is extremely high compared to other mushrooms. Hence, it can be stored for a longer period without deterioration which can directly help in marketing with minimum risk of spoilage.

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EFFECT OF SITE-SPECIFIC NUTRIENT MANAGEMENT ON CROP PRODUCTIVITY AND NUTRIENT REMOVAL OF RICE-WHEAT SYSTEM IN SOUTH BIHAR ALLUVIAL PLAINS

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ABSTRACT

A field experiment was conducted during 2003-04 to 2005-2006 at Bihar Agricultural College Farm, Sabour, Bhagalpur to study the effect of site-specific nutrient management (SSNM) on crop productivity and nutrient removal of rice (*Oryza sativa*) - wheat (*Triticum aestivum*) cropping system. The experiment comprised 10 treatment combinations, wherein farmer's fertilizer practice and state recommendation were compared with eight SSNM options. Pooled analysis revealed that application of 150 kg N, 30 kg P_2O_5, 100 kg K_2O in rice and wheat and 60 kg S/ha in rice only resulted in significantly higher values of straw yields, grain yields of rice (82.50 q/ha), rice-equivalent yield (155.9 q/ha) of the system and nutrient uptake by rice and wheat crops over the farmer's practice, state recommendation and the treatments in which either of the P_2O_5, K_2O and S were omitted from fertilizer schedule. The nutrient-use efficiency, apparent nutrient recovery and physiological efficiency of P_2O_5, K_2O and S were higher at their lower rates of applications. Largest gap between addition and removal was in case potassium followed by sulphur and phosphorus. The optimum dose of P_2O_5, K_2O and S for rice as per regression equation worked out to the extent of 44.10, 84.61 and 66.89 kg/ha, respectively whereas, optimum does of P_2O_5 and K_2O for wheat were 50.70 and 77.51 kg/ha, respectively.

Key words : Site specific nutrient management, productivity, rice-wheat system, phosphorus, potassium, sulphur.

Rice-wheat is the most dominant cropping system in India, covering about 9.7 million ha of area. The contribution of rice and wheat to national production has increased from 52 per cent in 1950s to 75 per cent in mid nineties (Kumar *et al.* 1999). It is distinguished as the back bone of the public distribution system (PDS) and a strong base for the food security of the country. Instances are there to show that the productivity of rice and wheat in some parts has already ceased to increase and in a few others, it has rather shown declining trends (Abrol, 1996 and Yadav *et al.* 1998). One of the major reasons for this decline is the large scale nutrient depletion through crop harvest on one hand and low level of replenishments through inadequate nutrient supply causing multi nutrient deficiencies and negative nutrient balances in the soil on the other (Yadav *et al.* 1998). Maintenance of soil fertility at healthy levels (supply of all nutrients in proportions matching with a crop's needs) is one of the key step towards safeguarding high productivity on a sustained basis. To meet the large nutrient needs of rice-wheat system, SSNM can facilitate the desired know how in an effective manner. Therefore, the present investigation was carried out for achieving maximum economic yields through site-specific nutrient management in rice-wheat system.

MATERIALS AND METHODS

A field experiment was conducted for three consecutive years from 2003-04 to 2005-06 on a fixed site at Bihar Agricultural College Farm, Sabour, Bhagalpur. The experimental soil was clay loam having pH 8.0 with organic carbon 0.47%, available N 175 kg/ha, P_2O_5 31.10 kg/ha, K_2O 185 kg/ha, S 22.0 kg/ha and available micronutrients were B 0.7, Cu 6.5, Fe 54.0, Mn 9.8 and Zn 4.7 mg/kg. The experiment was laid out in randomized block design with 4 replications. Based over soil analysis report, the treatment comprising combinations of 150 kg N/ha along with 3 levels each of P_2O_5 (0, 30 and 60 kg/ha), K_2O (0, 50 and 100 kg/ha) in rice and wheat crop and 4 levels of S (0, 20, 40, and 60 kg/ha) applied only in rice. The experiment comprised 10 treatment combinations, wherein Farmer's nutrient management practices (FP) and state recommendation (SR) were compared with eight site-specific nutrient management (SSNM) options ($SSNM_1$ to SSNM). In case of each of the nutrients applied, there had been an addition treatment in which it was not applied, so that its response could be calculated as per the missing plot techniques. The SSNM worked out to achieve an yield target of 9.0 t/ha in rice and 7.0 t/ha in wheat was kept at 150 kg N, 30 kg P_2O_5 and 100 kg K_2O in rice and wheat and 60 kg S only in rice. Succeeding wheat received only N, P and K fertilizers, as to assess the carry over effect of secondary nutrient (sulphur). Recommended doses of 100 kg N, 40 kg P_2O_5 and 20 kg K_2O/ha and 120 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha were applied in rice and wheat, respectively. A dose of 70 kg N, 30 kg P_2O_5 and 15 kg K_2O/ha was applied in both the crops as farmer's fertilizer practice treatments. The crop in all the plots were raised under optimum conditions. Apart from differences in nutrient application rates, all other practices were the same for SSNM, SR and farmer's practice. N,P, K and S were applied in the form of urea, diammonium phosphate, muriate of potash and elemental sulphur. Hybrid rice variety PHB -71 was transplanted by 1st week of July at a spacing of 20x10 cm and wheat variety HD 2733 was sown in last week of November with 20 cm row spacing. The hybrid rice was harvested in the last week of october and wheat was harvested in the 1st week of April. The prevailing market price of different commodities were used to work out the rice-equivalent yield of the system. The data on grain and straw yields obtained during 3 years were pooled and subjected to statistical analysis. Nutrient uptake of N, P, K and S by plants and nutrient-use efficiency for P_2O_5, K_2O and S were computed using standard procedures.

RESULTS AND DISCUSSION

Grain yield of rice and wheat

Among the three nutrients management options tried in the study, SSNM proved significantly superior to farmers practice and state recommendations. Application of 150 Kg N, 30 kg P_2O_5, 100 kg K_2O in both rice and wheat and 60 kg S/ha only in rice recorded the highest grain yield of hybrid rice (82.50 q/ha), wheat (53.81 q/ha) system productivity (136.31 q/ha) and rice-equivalent yield (155.9 q/ha), which brought an improvement of 32.28 q/ha in rice, 20.53 q/ha in wheat, 50.81 q/ha in system productivity and 52.69 q/ha in rice-equivalent yield over farmer's practice. The magnitude of such advantage over state recommendation were 21.58, 9.52, 31.40 and 35.90 q/ha, respectively (Table 1). Omission of any of the nutrient (P_2O_5 and K_2O in rice and wheat and S in rice) in spite of application of 150 kg N/ha and also the rest of nutrients, grain yields of rice and wheat as well as rice-equivalent yield decreased significantly than that recorded under the treatment giving the highest yield ($SSNM_6$). Dobermann *et al.* (2004) also reported significant increase in yield of rice through SSNM over local management practice. Significant yield advantage under SSNM treatments may be due to the application of higher amounts of nutrients increased the availability of nutrients in root zone and thus greater uptake of nutrients by plants resulted in higher grain production.

Effect of P_2O_5

Rice and wheat responded significantly only up to 30 kg P_2O_5/ha. Further increase in dose of phosphorus did not cause significant increase in grain and straw yield of either rice or wheat (Table 1). Application of 30 kg P_2O_5/ha in both the crops increased the yield of rice, wheat and rice-equivalent yield by 8.05, 5.36 and 15.40 q/ha over the crop raised without P-applications. The possible reason for increase in grain and straw yields with phosphorus fertilizers could be attributed to the fact that phosphorus plays a key role in root development. The increased root bio-mass might have improved the nutrient-uptake by exploiting greater volume of soil resulting in better physiological and metabolic functions inside the plant body which in turn laid down the foundation of higher yields in both the crops. These observations confirmed the findings of Sharma and Parmer (1998).

Table 1. Effect of site specific nutrient management on grain and straw yield of rice and wheat (mean of 3 years)

Treatment	Nutrients (kg/ha)				Grain yield (q/ha)		Increase over S.R. (q/ha)		straw yield (q/ha)		System	REY
	N	P_2O_5	K_2O	S*	Rice	Wheat	Rice	Wheat	Rice	Wheat	(q/ha)	(q/ha)
$SSNM_1$	150	30	100	40	80.87	52.36	20.25	8.07	109.8	74.2	133.23	152.3
$SSNM_2$	150	60	100	40	81.55	53.77	20.93	9.48	111.9	74.3	135.32	154.9
$SSNM_3$	150	0	100	40	72.82	47.00	12.20	2.71	100.4	66.2	119.82	136.9
$SSNM_4$	150	30	50	40	78.92	51.59	18.30	7.30	107.0	71.9	130.51	149.3
$SSNM_5$	150	30	0	40	70.40	45.52	9.78	1.23	96.8	63.2	115.92	132.5
$SSNM_6$	150	30	100	60	82.50	53.81	21.88	9.52	112.9	74.3	136.31	155.9
$SSNM_7$	150	30	100	20	75.01	49.61	14.39	5.32	103.3	69.5	124.62	142.7
$SSNM_8$	150	30	100	0	69.59	46.91	8.97	2.62	96.7	66.5	116.50	133.6
S.R.	100 (120)	40 (60)	20 (40)	0	60.52	44.29	-	-	88.2	62.8	104.91	120.0
F.P.	70	30	15	0	50.22	35.28	-	-	75.8	51.4	85.50	98.3
CD (P=0.05)					6.32	3.88	-	-	9.5	6.2	-	8.7

*Sulphur was applied to rice only, F.P. - Farmer's fertilizer practice

S.R. - State recommendation, REY - rice-equivalent yield

Effect of K_2O

Significant response in grain and straw yields of rice and wheat were recorded with the application of 50 kg K_2O/ha. Application of 50 kg K_2O/ha ($SSNM_4$) gave 8.52, 6.07 and 16.80 q/ha additional yield of rice, wheat and rice-equivalent yield over no K-application. Increasing dose beyond 50 kg K_2O/ha could not bring any significant yield advantage. Higher yields under K application was ascribed to increasing photosynthates activities, as K stimulates some vital bio-chemical properties like oxidative phosphorylation and photo-phosphorylation, that resulted in higher production of photosynthates and their translocation to sink, which might have directly contributed towards the better yield (Mengal, 1976).

Effect of sulphur

Skipping S application in rice caused significant drop in productivity of rice-wheat system, indicating the significance of replenishment of S in adequate amounts for achieving high yield target (Table 1). Application of gradient of S (0, 20, 40 and 60 kg/ha) in rice and their residual effect on wheat brought a linear increase in productivity of rice and wheat crop but the responses were significant only up to 40 kg/ha. At this application rate, rice and wheat crop had 11.28 and 5.45 q/ha yield gain at the rate of 16.2 and 11.6 percent, respectively over no S-application. The increase in grain yield of wheat with residual effect of S-application was also reported by Singh *et al.* (2005). This could be attributed to the fact that S application improved nutritional environment of rhizosphere as well as nutrient uptake and ultimately metabolic and photosynthetic activities, resulting in better yield of both the crops. Similar results were also reported by Dewal and Pareek (2004).

Nutrient uptake

The application of 150 kg N, 30 kg P_2O_5, 100 kg K_2O/ha in rice and wheat and 60 kg S/ha only in rice resulted in significantly higer N,P,K and S uptake by rice and wheat crops over farmer's practice, state recommendation and the treatment in which either of the P_2O_5, K_2O and S were skipped from fertilizer schedule (Table 2).

The application of fertilizers as per crop's needs increased its uptake by rice and wheat owing to increased in crop yield and partly its concentration in system.

Increasing levels of P_2O_5 and K_2O in rice and wheat, S in rice enhanced the P,K and S uptake by crops significantly up to 30 kg P_2O_5, 50 kg K_2O and 40 kg S/ha which increased its uptake by 20.0, 17.0 & 47.2 per cent in rice and 25.5, 24.0 and 2.6 per cent in wheat, respectively over control. Further increase in doses of P_2O_5, K_2O and S could not bring significant impact on P, K and S uptake. This increase in P,K and S uptake by crops can be ascribed to the influence of applied P_2O_5, K_2O and S on availability of nutrients in the soil as well as in view of prolific root system developed by balanced nutrient application giving rise to better absorption of water and nutrient. Moreover, the uptake followed the pattern of yield. These results are in close conformity with the findings of Viravipour *et al.* (1999) and Sharma and Bapat (2000).

Total N, P and K uptake data (Table 2) also revealed that in the process of producing 136.31 q/ha grain with the application of 150 kg N, 30 kg P_2O_5 and 100 kg K_2O/ha in rice and wheat and 60 kg S/ha only in rice the rice-wheat absorbed 749.6 kg N P_2O_5 + K_2O. This value was composed of 37.6% N, 13.0% P_2O_5 and 49.3% K_2O in a proportion of 100.35:131. On an average to produce a tonne of grain, rice absorbed 19 kg N, 6.90 kg P_2O_5 and 27.8 kg K_2O, the corresponding figures for wheat being 23.3 kg N, 7.6 kg P_2O_5 and 26.4 kg K_2O/ha. In addition to N, P and K the rice-wheat system absorbed 69.6 kg S/ha. Out of the total NPK uptake, the share of rice was 59 per cent and that of wheat was 41 per cent. The greater share of rice was primarily due to its higher productivity of hybrid rice and not due to higher nutrient content because on the basis of nutrient uptake one tonne wheat grain production absorbed more nutrient than rice (57.30 kg nutrient by wheat as compared to 53.7 kg for rice). The direct response of S-application of rice was 68.0 per cent of total response for the rice-wheat system, the balance 32.0 per cent being the residual effect on wheat. Similar results were reported by Tiwari and Sharma (2006).

Table 2. Nutrient uptake (kg/ha) by rice and wheat as influenced by site specific nutrient management (mean of 3 years)

Treatment	Nutrient (kg/ha)				Nutrient uptake (kg/ha)											
					Rice				Wheat				Rice-wheat system			
	N	P_2O_5	K_2O	S	N	P_2O_5	K_2O	S	N	P_2O_5	K_2O	S	N	P_2O_5	K_2O	S
$SSNM_1$	150	30	100	40	151.9	55.6	224.9	45.3	118.8	39.9	139.3	21.1	270.7	95.5	364.2	66.4
$SSNM_2$	150	60	100	40	156.6	57.4	226.7	45.9	124.7	42.2	140.1	21.6	281.3	99.6	366.8	67.5
$SSNM_3$	150	0	100	40	137.1	46.3	202.7	41.3	108.2	31.9	121.8	18.6	245.3	78.2	324.5	59.9
$SSNM_4$	150	30	50	40	151.9	53.6	201.9	44.6	119.8	38.7	127.8	20.5	271.7	92.3	329.7	65.1
$SSNM_5$	150	30	0	40	134.4	47.7	172.5	39.7	105.5	34.0	103.1	17.2	239.9	81.7	275.6	57.6
$SSNM_6$	150	30	100	60	158.0	57.0	229.4	47.4	124.1	40.6	140.5	22.2	282.1	97.6	369.9	69.6
$SSNM_7$	150	30	100	20	145.2	51.1	207.9	40.5	114.6	38.1	130.3	19.2	259.8	89.2	338.2	59.7
$SSNM_8$	150	30	100	0	134.1	48.1	191.6	30.8	108.2	35.8	123.6	16.7	242.3	83.9	315.2	47.5
S.R.	100 (120)	40 (60)	20 (40)	0	115.6	44.9	179.6	26.6	94.3	34.3	110.8	15.6	209.9	79.2	290.4	42.2
F.P.	70	30	15	0	89.0	34.6	136.2	21.9	72.0	25.8	85.8	12.3	161.0	60.4	222.0	34.2
CD (P=0.05)					7.3	3.6	12.5	3.0	5.8	2.2	9.6	1.8	13.3	6.2	22.6	4.9

Nutrient-use-efficiency

Application of P_2O_5, K_2O in both rice and wheat and S in rice only had a favorable influence on nutrient use efficiency, physiological efficiency and apparent nutrient recovery. In the absence of no - N plot, a comparable figure could not available. The nutrient use efficiency (kg grain/kg nutrient applied), physiological efficiency (kg grain/kg nutrient uptake) and apparent nutrient recovery increased with increasing levels of P_2O_5, K_2O and S up to 30, 50 and 40 kg/ha, respectively and it tended to decline with their higher levels. The higher nutrient - use efficiency was mainly due to higher grain production per unit of P K and S applied. The apparent nutrient efficiency also followed the same trend probably due to greater P, K and S uptake per unit of P_2O_5 K_2O and S added and physiological efficiency owing to production of more biomass production. As enhanced supply of P_2O_5, K_2O and S diminished the nutrient-use efficiency, physiological efficiency and apparent nutrient recovery in one hand and on the other hand, increasing level of P_2O_5 enhanced nutrient use efficiency and apparent recovery of K and S. Similarly increasing levels of K helped in increasing efficiencies of P and S and also greater S supply improved the nutrient-use efficiency and apparent nutrient efficiency of P and K. This can be explained by considering the interaction effects between P and K, P and S, K and S. These results are in close conformity with those of Suja *et al.* (2003).

Nutrient input-output ratio provide a measure of whether and to what extent nutrient uptake exceeds nutrient additions. Data revealed that uptake of N was almost balanced the N input but mean uptake of P, K. and S was 1.57, 2.01 and 1.78 times the P, K and S uptake, indicating a stress on P, K and S supplies. Largest gap between addition and removal was in case of potassium followed by sulphur and phosphorus. These results cofirm the findings reported by Tiwari and Sharma (2006).

Response functions

The response to phosphorus, potassium and sulphur in respect of grain yield of rice of wheat were worked out by fitting response equations

Table 3. Effect of site specific nutrient management on nutrient - use efficiency in rice-wheat system

Nutrient applied in rice-wheat system (kg/ha)	Nutrient use efficiency (kg grain/kg nutrient applied)			Physiological efficiency (kg grain/kg nutrient uptake)			Apparent nutrient recovery (%)			Nutrient input-output ratio		
	P_2O_5	K_2O	S	P_2O_5	K_2O	S	P_2O_5	K_2O	S	P_2O_5	K_2O	S
P_2O_5												
60	22.4	8.7	41.8	139.9	36.6	200.6	28.8	44.3	47.3	1.59	1.82	1.66
120	12.9	9.7	47.1	135.9	36.9	200.5	17.8	45.6	50.0	0.83	1.82	1.69
K_2O												
100	17.8	14.6	35.0	141.4	39.6	200.5	23.5	54.0	44.0	1.54	3.30	1.63
200	22.4	8.7	41.8	139.5	36.6	200.6	28.8	44.3	47.3	1.59	1.82	1.66
S*												
20	8.0	4.4	22.0	139.7	36.8	208.7	18.3	31.1	61.0	1.49	1.69	2.98
40	22.4	8.7	41.8	139.5	36.6	200.6	28.8	44.3	47.3	1.59	1.59	1.66
60	27.5	10.2	33.0	139.7	38.9	195.8	32.3	47.2	36.8	1.63	1.63	1.16

*Sulphur was applied to rice only

and following regression equations for P_2O_5, K_2O and S were obtained from grain yields data over three years.

Phosphorus : Rice : $Y = 72.82 + 0.39\,X - 0.0041\,X^2$

Wheat : $Y = 47.00 + 0.24\,X - 0.0022\,X^2$

Potassium : Rice : $Y = 70.40 + 0.24\,X - 0.0013\,X^2$

Wheat : $Y = 45.52 + 0.17\,X - 0.0011\,X^2$

Sulphur : Rice : $Y = 69.36 + 0.37\,X - 0.0024\,X^2$

Where Y, Grain yield (q/ha ; X, dose of specific nutrient.

These equations revealed that response to phosphorus, potassium and sulphur were quadratic, indicating the operation of the law of diminishing return. As per above equations, the optimum dose of P_2O_5, K_2O and S for rice were worked out to be 44.10, 84.61 and 66.89 kg/ha, respectively. The corresponding values of optimum yield were 82.11, 80.97 and 83.18 q/ha, respectively. The optimum dose of P_2O_5 and K_2O for wheat were also calculated, which were 50.70 and 77.51 kg/ha and their corresponding yield were 53.76 and 52.67 q/ha, respectively. As compared to the state recommendation for K_2O *i.e.*, 20 and 40 kg/ha for rice and wheat developed long back, the computed value of K_2O requirement for rice and wheat were much higher. This may be attributed to continuous application of very low doses of K_2O than that taken up by crops. Application of lower doses of K_2O had been under the notion that Indian soils are very rich in potash content. However, intensive cropping, cultivation of high yielding crops and varieties has depleted K reserves and now higher doses of K_2O shall have to be applied for maintenance of soil fertility and sustainability of yield in rice-wheat system. The P_2O_5 doses under recommendation are close to that worked out under this experiment. However, S application appears to be an essential nutrient for increasing crop productivity in rice-wheat system.

The results of this investigation indicate that the existing fertilizer recommendations for NPK are proving to be sub-optimal for attaining higher productivity levels and need a fresh look to revise them towards optimal and more balanced levels. Balanced application of N, P_2O_5, K_2O and S as per crop needs can increase the grain productivity of rice-wheat system by 31.0 q/ha and can contribute towards breaking this stagnation in yields and bridging the yield gap.

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ESTIMATION OF PRODUCTION OF IMPORTANT FLOWERS ON THE BASIS OF MARKET ARRIVAL IN DELHI

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ABSTRACT

At present, no scientific methodology for reporting of area and production under flowers is available. Although National Horticulture Board (NHB) publishes area and production figures, these are not based on any statistical and scientific procedure. The already existing crop-cutting experiment approach being following in case of other crops would be cost-prohibitive for developing estimates of area and production of flowers. This is due to multiple pickings involved in case of flowers. In this context, the National Statistical Commission has recommended the need to develop a suitable sampling methodology for estimation of area and production of flowers on the basis of market arrivals. Therefore, Indian Agricultural Statistics Research Institute conducted a study entitled "Pilot sample survey to develop sampling methodology for estimation of area, production and productivity of important flowers on the basis of market arrivals" with the objective of developing precise estimates of the production of important flowers on the basis of market arrivals in Delhi. As a part of this study a sample survey was carried out in the three flower mandis of Delhi namely, Khari Baoli mandi, Hanuman Mandir mandi and Mehrauli mandi of Delhi during September 2003 to August 2004 to collect the data on market arrivals of important flowers in the flower mandis.

The sampling design for estimation of production on the basis of market arrivals was one of stratified random sampling in each flower mandi. The commission agents/mashakhors in the mandis of Delhi comprise the first stratum while self-selling farmers the second stratum. Cut flowers of rose, Gladiolus, Chrysanthemum, Tube-rose, Carnation and other seasonal flowers are mainly traded in the Hanuman Mandir Mandi. In Fatehpuri and Mehrauli Mandi, trading is done in loose flowers of Marigold, Rose, Margaret and Jaffrey etc. Keeping in view the trend of flower arrivals in the mandis, the entire survey period September 2003, August 2004 was divided into three periods *viz.* PI: September - December 2003, P-II : January-April 2004 and P-III : May-August 2004.

Total market arrivals of loose flowers from Delhi as well as outside Delhi were found to be 14570.910 MT with 2.51% SE and 25829.580 MT with 1.50% SE, respectively. The corresponding figures for cut flowers were 670.68820 lakh with 1.535 SE and 2380.80237 lakh with 0.74% SE. The percentage of market arrival of loose flowers from Delhi and outside Delhi, respectively, was of the order of 36% and 64%. The corresponding figures in case of cut flowers were 22% and 78%. This study is first of its kind on "estimation of flower production on the basis of market arrivals". The percentage standard errors of the estimates are within reasonable limits (to the tune of 5%) which is indicative of the fact that the estimated figures are reasonably precise.

Key words : Flowers, multi-stage random sampling market, arrivals, stratum, commission agents, self-selling farmers.

Floriculture, which was till a few years ago, considered only a gardening activity related to growing of flowers to be used mainly for religious offering and decoration, has in the recent times blossomed into a commercial enterprise. India's entry in the floriculture trade was made possible in 1969, through the efforts of the floriculture scientists of the Indian Agricultural Research Institute (IARI) in collaboration with the State Trading Corporation (STC) of India. Following the Green Revolution in Agriculture, flowers are now considered to be one of the best crops for diversification. To promote the floriculture industry in India, the Government has provided subsidies, duty concessions and other incentives.

India has a good potential for floriculture due to favourable climatic conditions for production of flowers during winter (October-March). Other factors like the geographic location, availability of cheap labour and abundant soil space puts India in an advantageous positionfor commercial production of flowers.

At present, an objective method of reporting of area and production under flowers is not available. Although National Horticulture Board (NHB) publishes area and production figures, these are not based on any statistical and scientific procedure. The already existing crop-cutting experimental approach being followed in case of other crops would be cost-prohibitive for developing estimates of area and production figures, these are not based on any statistical and scientific procedure. The already existing crop-cutting experimental approach being followed in case of other crops would be cost-prohibitive for developing estimates of area and production of flowers. This is due to multiple pickings involved in case of flowers. In this context, the National Statistical Commission has recommended the need to develop a suitable sampling methodology for estimation of area and production of flowers on the basis of market arrivals. With the growing demand for the need of building reliable estimates of area and production of flowers, Indian Agricultural Statistics Research Institute conducted a study entitled "Plot sample survey to develop sampling methodology for estimation of area, production and productivity of important flowers on the basis of market arrivals" with the objective of developing precise estimates of the production of important flowers on the basis of market arrivals in Delhi.

MATERIALS AND METHODS

There are three flower mandis in Delhi namely, Hanuman Mandir Mandi, Khari Baoli Mandi and Mehrauli Mandi. Cut flowers of Rose, Gladiolus, Chrysanthemum, Tube-rose, Carnatinand other seasonal flowers are mainly traded in the Hanuman Mandir Mandi. In Fatehpuri and Mehrauli Mandi, trading is done in loose flowers of Marigold, Rose, Mandis, the entire survey period September 2003 to August 2004 was divided into three periods viz. P-I: September-December 2003, P-II : January - April 2004 and P-III : May-August 2004.

The data on varieties of flowers sold by the commission agents and self-selling farmers placed in the three mandis was collected by inquiry. Data on the kind and quantity of flowers from outside Delhi based farmers was also recorded in the three madis to get an idea of volume of flowers being traded by this category of farmers.

The sampling design for the purpose of data collection for the varieties of flower sold on the basis of market arrival was one of stratified random sampling in each flower mandi where in commission agents were classified into first stratum and the self-selling farmers in to the second stratum.

With in first stratum, 7 random groups of commission agents dealing with each flower were formed to cover all the commission agents trading in each of the two mandi. Each random group was observed with a specific systematic plan in order to cover all the three periods each of four months duration. Similarly, a suitable number of self selling farmers were selected for the purpose of making inquiry about availability of flowers sold. A self selling farmer once chosen was not repeated in the particular period of inquiry. One group was randomly selected and observed for a fortnight in one period by two field investigators hired on contractual basis for data collection purpose.

The remaining 6 groups were observed in a similar manner. Thus all the 7 groups were observed in seven fortnights in one period. This process was repeated in the other two periods. All the commission agents of Mehrauli mandi were observed for 8 days in each period. The data on flowers in this mandi was collected by the two field investigators. In this way, data have been collected for the entire year on trading of important flowers from all the commission agents and self-selling farmers in each flower mandi of Delhi.

Estimation Procedure

Let there be

- k-kinds of flowers grown in Delhi
- 3 periods viz. P1 (1st September to 31st December, 2003-122 days, P2 (1st January to 30th April, 2004-121 days) and P3 (1st May to 31st August, 2004-123 days)
- 2 Strata viz. stratum 1 of commission agents/ mashakhors and straum 2 of self-selling farmers.
- Seven groups (Each group comprises suitable number of commission agents/mashakhors from 1st stratum and self selling farmers from the 2nd stratum.

Estimation of total market arrival of Delhi for Kth kind of flower in the ith period

The parameter of interest is flower (kind-wise) market arrivals from Delhi. Eastimation of market arrival of kth kind of flower for the ith period is discussed as under :

Let y_{ghad} be the market arrival of the flower for gth group, hth stratum, ath commission agent/ self selling farmer on dth day. Thus

Mean market arrival per day for gth group, hth stratum ath commission agent/self selling farmer is $\bar{y}_{gha} = \sum_{d}^{m_h} \frac{y_{ghad}}{m_h}$

where mh is the number of days for which selected sample of commission agent/ self selling farmers are to be observed.

Estimated market arrival per day per commission agent/self selling farmer in the hth stratum of gth group is

$$\bar{y}_{gh} = \frac{1}{n_h}\sum_{a}^{nh} and\ \hat{V}(\bar{y}_{gh.}) = \left(\frac{1}{n_h} - \frac{1}{N_h}\right)\left(\frac{1}{n_h - 1}\right)\sum_{a}^{nh}(\bar{y}_{gha} - \bar{y}_{gh.})^2,$$

where Nh are the total number of agents in the hth stratum and n^h are number of agents observed in the hth stratum of gth group.

Estimated total market arrival per day for the mandi on the absis of gth group is

$$\hat{Y}_{g..} = \sum_{n} N_h \bar{y}_{gh.}\ and\ \hat{V}(\hat{Y}_{g..}) = \sum_{h} N^2{}_h V(\bar{y}_{gh.})$$

Estimated total market arrival per day for the mandi averaged over all groups for the ith period is

$$\hat{Y}...(i) = \frac{1}{g}\sum_{g}\hat{Y}g..and \hat{V}\left(\hat{Y}_{...(i)}\right) = \frac{1}{g^2}\sum_{g}\hat{V}(\hat{Y}_{g..})$$

Estimate of total market arrival for the entire year (366 days) for the kth kind of flowers is

$$\hat{Y}...122\hat{Y}_{...(i)} + 121\hat{Y}_{...(2)} = +123\hat{Y}_{...(3)}$$

While the corresponding estimate of variance of is given by

$$\hat{V}(\hat{Y}...) = (122)^2\hat{V}(\hat{Y}_{...(1)}) + (121)^2\hat{V}(\hat{Y}_{...(2)}) + (123)^2\hat{V}(\hat{Y}_{...(3)})$$

Estimates of total market arrivals for all kind of flowers grown in Delhi in Delhi have been obtained on similar lines.

RESULTS AND DISCUSSION

Table 1 provides estimate in Metric Tonnes (MT) of different flowers produced in Delhi and outside Delhi for the three periods as well as pooled estimates for Khari Baoli Flower Mandi.

The results reveal that estimate of rose from Delhi was 776.879 MT with 1.54% SE, 398.128 MT with 2.42% SE, 545.755 MT with 2.05% SE and 1720.762 MT with 1.11% SE for period I, period II, period III and pooled over all the three periods, respectively. Corresponding estimates of rose from outside Delhi was found to be 191.262 MT with 5.50% S E. It is clear from the table that the estimated figure for rose from Delhi is higher than the one from outside Delhi.

Estimates of Marigold flower in Delhi as well as outside Delhi ranged from 1420.119 MT with 4.30% SE and 87.66.301 MT with 2.65% SE. Corresponding figures for Jaffrey and Margaret (White/yellow) were in the ranged of 8302.226 MT with 4.11% SE to 73976.15 MT with 3.89% S E and 1746.754 SE to 1299.634 MT with 7.50% S E, respectively.

Table 1. Estimate of flowers (MT) in Khari Baoli Flower Mandi

Flower	Period I		Period II		Period III		Overall	
	Delhi Estimate	Outside Delhi Estimate	Delhi Estimate	Outside Delhi Estimate	Delhi Estimate	Outside Delhi Estimate	Delhi Estimate	Outside Delhi Estimate
Rose	776.879	191.262	398.128	368.260	545.755	311.276	1720.762	870.798
	(1.54)	(5.50)	(2.42)	(6.77)	(2.05)	(8.00)	(1.11)	(4.22)
Marigold	750.365	3801.839	655.364	1123.093	14.391	3841.369	1420.119	8766.301
	(1.15)	(2.64)	(9.23)	(4.28)	(*)	(3.30)	(4.30)	(2.65)
Goldawari	27.145	676.538	-	101.081	-	-	27.145	777.664
	(*)	(3.89)		(*)			(*)	(2.18)
Rajnigandha	-	85.263	-	147.576	12.300	105.067	12.300	337.907
		(1.19)		(4.25)	(*)	(3.55)	(*)	(2.18)
Jaffery	2065.460	2986.771	6235.658	4410.844	-	-	8302.226	7397.615
	(1.75)	(3.66)	(5.44)	(6.03)			(4.11)	(3.89)
Margret White/Yellow	186.998	31.110	1558.649	1268.524	1.107	-	1746.754	1299.634
	(2.96)	(*)	(6.90)	(7.68)	(*)	-	(6.16)	(7.50)
Other's**	35.701	76.575	3.630	167.718	62.976	220.255	102.307	464.548
	(1.94)	(3.20)	(*)	(6.54)	(4.13)	(3.69)	(2.63)	(2.98)
Total Production	3842.548	7849.403	8851.429	7587.096	637.636	4477.968	13331.613	19914.467
	(1.03)	(1.93)	(4.08)	(3.80)	(1.80)	(4.59)	(2.73)	(1.93)
Proportionate (%)	32.86	67.14	53.85	46.15	12.46	87.54	40.10	59.90

Note: 1. Figures in brackets indicate corresponding percentage standard errors.
2. *-based on very few observations.
3. ***- Include Dodhi, Raibel, Caner (Red), Tube Rose (Double), Navrang and Aster.

Period-wise total market arrival of all kind of flowers produced in Delhi were estimated as 3842.548, 8851.429 and 637.636 MT with percent standard errors 1.03, 4.08 and 1.80, respectively for the three periods. Corresponding Fig. for period-wise total market arrival of flowers produced outside Delhi were estimated as 7849.403, 7587.096 and 4477.968 MT with percent standard errors 1.93, 3.80 and 4.59.

Overall estimated of market arrival in Khari Baoli flower mandi from Delhi and outside Delhi were obtained. These figures were 13331.613 with 2.73% S E and 19914.467 MT with 1.93% S E respectively.

Of the total market arrival in period III, 87.54% was found from outside Delhi while 53.85% of arrival in period II was from Delhi. When computed on pooled basis, two fifth of the total flower market arrival was from Delhi.

Table 2 provide estimates in lakh numbers of different kind of cut flowers produced in Delhi and outside Delhi and outside Delhi for the three periods in Hanuman Mandir Flower Mandi. Pooled estimates area also provided.

The results revealed that the estimated number of Super Rose from Delhi were 276.01665 with 3.16% S E, 210.70762 with 2.15% S E, 84.73619 with 1.89% S E and 571.46046 with 1.74% S E for period I, period II, period III and over all the three periods, respectively. Corresponding market arrivals from outside Delhi were 142.36789 with 4.01% S E, 104.29790 with 5.63% S E, 166.12782 with 2.46% S E and 412.79361 with 2.04% S E.

The market arrival of Gladiolus flower was mostly reported from outside Delhi and the figures were 244.89463, 262.86744, 348.01027 and 855.77234 for the three periods and overall the period, respectively. The market arrival of Tube Rose (Double) was observed to be the highest for period III i.e. 272.87068 with 1.54% S E.

On the whole, whereas the market arrival of Super Rose was found to be highest from Delhi, the market arrival of Gladiolus was reported to be highest from outside Delhi followed by Super Rose and Tube Rose (Double).

Period-wise total market arrival in lakh numbers of all kind of flowers produced in Delhi was estimated to be 354.35129, 231.60071 and 84.73619 while fro outside Delhi, it was of the order of 809.47600, 528.28154 and 1043.04484 in the three periods, respectively. Total market arrivals from Delhi and outside Delhi were 670.68820 with 1.53% S E and 2380.80237 with 0.74% S E, respectively.

The results clearly indicate that of the total market arrival both for period I and period II, 30% of the total market arrival was from Delhi while for the third period it was only 8%. It may also be seen that flowers from outside Delhi accounted for the bulk of flowers (78%) traded in Hanuman mandir flower mandi.

Table 3 provide estimates in metric tonnes (MT) of different kind of flowers produced in Delhi and outside Delhi for the three periods as well as estimates pooled over all the three periods in Mehrauli Flower Mandi.

It can be seen from the Table 3 that estimate of Rose from Delhi was found to be highest 87.908 MT with 1.61% S E for period III while the lowest i.e. 41.435 MT with 3.37% S E was obtained for period II. Estimate of Rose from outside Delhi was observed highest in period III (168.196 MT with 3.39% S E). Pooled estimated market arrival of Rose from Delhi and outside Delhi were 175.788 MT with 1.37% S E and 242.116 MT with 2.44% S E, respectively.

Among the arrivals of different kind of flowers in the Mandi, pooled estimate of Marigold from outside Delhi was found to be highest 2832.202 MT with 0.92% S E followed by Jaffrey i.e. 1811.818 MT with 1.42% S E. Estimate of Jaffrey from Delhi was observed Rose 175.788 MT with 5.41% S E followed by Marigold 307.052 MT with 4.41% S E. Rose 175.788 MT with 1.37% S E and Margaret 152.281 MT with 6.72% S E. The estimate of other flowers (Dodhi, Raibel, Caner and Dhela) from Delhi was found to be of the order of 0.854 MT with 10.10% S E while from outside Delhi, it was 231.496 MT with 1.22% S E.

Proportion of market arrival of different kind of flowers from Delhi and outside Delhi

Table 2. Estimate of cut flowers (Lakh numbers) in Hanuman Mandir Flower Mandi

Flower	Period I		Period II		Period III		Overall	
	Delhi Estimate	Outside Delhi Estimate	Delhi Estimate	Outside Delhi Estimate	Delhi Estimate	Outside Delhi Estimate	Delhi Estimate	Outside Delhi Estimate
Rose	276.01665	142.36789	210.70762	104.29790	84.73619	166.12782	571.46046	412.79361
	(3.16)	(4.01)	(2.15)	(5.63)	(1.89)	(2.46)	(1.74)	(2.04)
Guldawari	25.38962	52.12085	1.54880	-	-	-	26.93842	52.12085
	(8.22)	(3.56)	(*)				(7.75)	(3.56)
Rajnigandha	10.81733	92.60641	-	33.14862	-	-	10.81733	125.75503
	(6.11)	(4.37)		(6.31)			(6.11)	(3.62)
Gerbera	-	77.41249	-	42.79697	-	116.19516	-	236.40463
		(6.89)	-	(4.52)		(1.26)		(3.10)
Gladiolus	14.05386	244.89463	-	262.86744	-	348.01027	14.05389	855.77234
	(3.77)	(5.75)	-	(1.82)	-	(1.35)	(3.77)	(0.94)
Orchid	-	45.33245	-	29.18809	-	67.41311	-	141.93365
		(6.98)		(3.15)		(2.48)		(4.09)
Carnation	-	68.73822	-	29.01003	-	59.06735	-	141.93365
		(5.17)		(3.16)		(2.44)		(3.73)
Tube Rose	2.76533	19.90227	-	3.68082	-	272.87068	2.76533	296.45376
(Double)	(*)	(2.44)		(*)		(1.54)	(*)	(3.24)
Others**	25.30849	66.10079	19.34429	23.29166	-	13.36044	44.65279	102.75290
	(4.40)	(5.01)	(1.97)	(1.32)		(*)	(2.63)	(3.24)
Total	354.35129	809.47600	231.60071	528.28154	84.73619	1043.04484	670.68820	2380.80237
Production	(2.56)	(1.43)	(1.96)	(1.40)	(1.89)	(1.06)	(1.53)	(0.74)
Proportionate	30.45	69.55	30.48	69.52	7.51	92.49	21.98	78.02

Note:
1. Figures in brackets indicate corresponding percentage standard errors.
2. *-based on very few observations.
3. ***- Include Marigold, Lucky Bamboo, Lilium, B.O.P., Seeterina, Anthorium, Gipshy, Multi Glad, Chandni-Tup, Nargis and Bottle Brush.

Table 3. Estimate of flowers (MT) in Mehrauli flower mandi

Flower	Period I		Period II		Period III		Overall	
	Delhi Estimate	Outside Delhi Estimate	Delhi Estimate	Outside Delhi Estimate	Delhi Estimate	Outside Delhi Estimate	Delhi Estimate	Outside Delhi Estimate
Rose	46.445	55.952	41.435	17969	87.908	168.196	175.788	242.116
	(2.94)	(2.14)	(3.27)	(5.27)	(1.61)	(3.39)	(1.37)	(2.44)
Marigold	38.430	299.344	106.467	663.686	162.155	1869.172	307.052	2832.202
	(8.62)	(4.07)	(4.79)	(1.64)	(7.47)	(1.08)	(4.41)	(0.92)
Guldawari	6.506	408.793	-	-	-	-	6.506	408.793
	(*)	(2.06)					(*)	(2.06)
Rajnigandha	1.220	-	-	1.210	-	8.200	1.220	9.410
	(*)			(*)		(7.64)	(*)	(6.66)
Jaffrey	447.384	1182.790	148.210	629.028	-	-	595.594	1811.818
	(6.77)	(1.97)	(7.39)	(1.73)			(5.41)	(1.42)
Margaret	9.760	100.489	142.521	278.785	-	-	152.281	379.274
(White/Yellow)	(*)	(3.28)	(7.18)	(2.02)			(6.72)	(1.72)
Other's	0.854	0.244	-	66.598	-	164.654	0.854	231.496
	(10.10)	(*)		(3.10)		(1.17)	(10.10)	(1.22)
Total	550.599	2047.611	438.633	1657.275	250.063	2210.222	1239.295	5915.108
production	(5.54)	(1.36)	(3.62)	(1.00)	(4.88)	(0.96)	(2.95)	(0.65)
Proportionate %	21.19	78.81	20.93	79.07	10.16	89.84	17.32	82.68

Note : 1. Figures in brackets indicate corresponding percentage standard errors.
2. *-based on very few observations.
3. ***- Include Dodhi, Raibel, Caner (Red) and Dhela.

Table 4. Estimate of arrival of different kind of flowers in Delhi on the basis of market arrival in the three mandis

Flower	Loose (MT)				Cut (Lukh Number)			
	Delhi		Outside Delhi		Delhi		Outside Delhi	
	Estimate	% S E	Estimate	% S E	Estimate	% S E	Estimate	% S E
Rose	1896.550	1.02	1112.914	3.34	517.46046	1.74	412.79361	2.04
Marigold	1727.171	3.62	11598.500	2.02	-	-	-	-
Guldawari	33.651	*	1186.457	2.33	26.93842	7.75	52.12085	3.56
Rajnigandha	13.520	*	347.317	2.13	10.81733	6.11	125.75503	3.62
Jaffrey	8897.820	3.85	92.09433	3.14	-	-	-	-
Margaret (White/Yellow)	1899.035	5.69	1678.908	5.82	-	-	-	-
Gladiolus	-	-	-	-	14.05386	3.77	8.5577234	0.94
Gerbers	-	-	-	-	-	-	236.40463	3.10
Orchid	-	-	-	-	-	-	141.93365	4.09
Carnation	-	-	-	-	-	-	156.81560	3.73
Tube Rose (Double)	-	-	-	-	2.76533	*	296.45376	1.43
Others	103.161	2.61	696.044	2.03	44.65279	2.63	102.75290	3.24
Total Production	14570.910	2.51	25829.580	1.50	670.68820	1.53	2380.80237	0.74
Proportional	36.7		63.93		21.98		78.02	

Note: 1. *-based on very few observations.

are also presented in the table. It can be seen that, both for period I and II, two fifth of the market arrival was from Delhi whereas it was only one tenth for period III. When pooled over the three periods, the percentage market arrival from Delhi and outside was 17 and 83.

Estimates of the total market arrival of loose flowers in flowers in Metric Tonnes as well as of cut flowers in lakh numbers along with their percent standard erros in the three flower Mandis from Delhi and outside Delhi are presented in Table 4.

The estimate of loose flowers of Rose from Delhi was 1896.550 MT with 1.02% S E while from outside Delhi it was 1112.914 MT 3.34% S E. The corresponding market arrival for Marigold was 1727.171 MT with 3.62% S E and 11.598.500 MT with 2.02% S E while the same for Jaffrey were 88937.820 MT with 3.85% S E and 9209.433. MT with 3.14% S E. Similarly, in case of Margaret, the corresponding figures were 1899.035 MT with 5.69% S E and 1678.908 MT with 5.82% S E.

The estimates of production of cut flowers from Delhi and outside Delhi are also presented in Table 2. These figures for Rose were 571.46046 lakh with 1.74% S E and 412.79361 lakh with 2.04% S E, respectively. The estimates of production of other varieties of cut flowers from outside Delhi were found to be 855.77234 lakh with 0.94% S E, 296.45376 lakh with 1.43% S E, 236.40463 lakh with 3.10% S E and 156.81560 lakh with 3.73% S E for Gladiolus, Tube Rose (Double), Gerbera and Carnation, respectively.

Total market arrivals of loose flowers from Delhi as well as outside Delhi were found to be 14570.910 MT with 2.51% S E and 25829.580 MT with 1.50% S E. The corresponding figures for cut flowers were 670.68820 lakh with 1.53% S E and 2380.80237 lakh with 0.74% S E. The percentage of market arrival from Delhi and outside Delhi respectively was of the order of 36% and 64%. The corresponding figures in case of cut flowers were 22% and 78%.

This study is first of its kind on "estimation of flower production on the basis of market arrivals". It may be seen that percentage standard errors of the estimates are within reasonable limits (to the tune of 5%) which is indicative of the fact that the estimated figures are reasonably precise.

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SEASONAL EFFECT ON FRUIT YIELD AND STUDY OF GENETIC VARIABILITY ON INDIGENOUS GERMPLASM LINES OF SPONGE GOURD (*LUFFA CYLINDRICAL* ROEM.)

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ABSTRACT

Genetic variation for 15 yield attributes were compared in 48 indigenous germplasm lines of sponge gourd for summer and rainy seasons. The genotypes PSG 171, PSG 199, PSG 40, PSG 59, PSG 192, were heavy yielder during summer season whereas, PSG 199, PSG 195, PSG 187, PSG 170 and PSG 192 genotypes gave high yield during season. It is clearly focused that the genotypes differs in their yield potential according to season. High PCV and GCV were observed for fruit yield, number of fruit per plant and node number of first male flower in summer and rainy seasons. Highest ECV was found with number of primary branches for both the seasons. High heritability coupled with high genetic advance during summer and rainy seasons were recorded for fruit yield, number of fruits per plant and node number of first female flower.

Key words : Yield, variability, sponge gourd, genetic parameters.

Sponge gourd is originated in subtropical Asian region particularly, India (Kalloo, 1993). Sponge gourd is an important member of the family Cucurbitaceous, which is extensively grown during summer and rainy seasons. The crop grown in rainy season gives heavy yield as compared to summer season. Sponge gourd is commonly grown for its tender fruits as well as for sponge which is used for scrubbing purposes. Tender fruits are rich in vitamin 'A', vitamin 'C' and iron (Yawalkar, 2004). Magnitude of variation play vital role in development of high yielding sponge gourd varieties. Therefore, the present study was undertaken to find out the season effect on yield and study of genetic variation, heritability and genetic advance.

MATERIALS AND METHODS

Forty-eight indigenous germpasm lines of sponge gourd were evaluated the randomized block design with three replications during summer and rainy seasons, 2005 at Vegetable Research Centre, Pantnagar. Seeds were sown on each side of the channels in well prepared hills. Each treatment comprised of five hills and one plant was allowed to grow per hiss. All the recommended agronomic practices were followed to raise a healthy crop. The observations were recorded on five random plant basis per replication for each entry on 13 quantitative characters viz., days to anthesis of first male flower, node number of first male flower, days to anthesis of first flower, node number of first female flower, fruit length, fruit perimeter, flesh thickness, average fruit weight, number of fruits per plant, days to first fruit harvest, days to last fruit harvest, duration of fruit (maturity period), number of primary branches, vine length and fruit yield. The mean values obtained were utilized for variability, heritability and genetic advance estimation as per formula given by Burton and Devane (1953).

RESULTS AND DISCUSSION

The per se performance was presented in Table 1 during summer season and Table 2 during season indicated that PSG 71 (111.13 q/ha), PSG 191 (110.0 q/ha), PSG-40 (99.31 q/ha) and PSG 59 (95.88 q/ha) were top yielder for summer season, while, the genotypes having high yield during rainy season were PSG 195 (101.44 q/ha), PSG 187 (97.38 q/ha), PSG 170 (91.31 q/ha) and PSG 192 (86.88 q/ha). One genotype, PSG 199 gave high yield during summer (110.75 q/ha) and rainy (114.44 q/ha) seasons.

Table 1. Mean performance of genotypes in summer season

Geno-Types	Days to anthesis of 1st male flower	Node no. of 1st male flower	Days to anthesis of 1st female flower	Node no. of 1st female flower	Fruit length (cm)	Fruit peri-meter (cm)	Flesh thick-ness (cm)	Average fruit weight (g)	No. of fruits/ plant	Days to harvest 1st fruit	Days to harvest last fruit	Duration of fruit harvest	No. of primary bran-ches	Vine length (m)	Fruit yield/ plot (kg)	Total yield (q/ha)
PSG 39	63.37	3.67	70.33	10.33	19.67	12.23	3.03	141.00	17.00	80.33	125.00	44.67	3.33	5.08	12.54	78.38
PSG 40	70.33	3.33	76.67	12.33	23.40	13.46	3.76	168.33	19.33	83.67	130.67	47.00	3.67	4.93	15.89	99.31
PSG 50	63.67	6.67	68.33	11.67	25.60	13.80	3.53	144.33	9.67	76.67	116.00	39.33	4.67	6.93	6.71	41.94
PSG 59	60.33	3.67	65.33	14.33	24.46	14.53	4.53	162.67	19.33	76.67	123.00	44.00	4.33	4.96	15.34	95.88
PSG 61	61.33	5.33	66.33	11.33	20.40	14.33	4.13	136.33	22.33	74.33	121.00	46.67	4.33	5.56	15.22	95.13
PSG 62	73.00	7.33	77.00	17.66	19.76	11.73	3.56	128.67	7.33	83.33	128.33	45.00	5.33	51.56	4.34	27.13
PSG 65	65.33	5.33	68.33	17.00	27.76	13.90	3.73	191.33	15.00	74.33	113.33	38.33	5.33	5.86	12.89	80.57
PSG 170	68.33	4.67	70.67	14.00	26.53	13.83	3.83	121.67	18.67	81.00	116.67	35.67	5.67	4.90	11.12	69.50
PSG 71	69.00	6.33	70.00	14.00	25.26	13.40	3.70	187.00	20.33	77.66	114.67	37.00	5.33	5.31	17.78	111.13
PSG 74	62.33	6.33	69.67	14.67	22.53	12.30	3.90	154.67	14.00	76.33	113.00	36.67	4.33	5.69	10.70	66.88
PSG 75	66.67	5.33	73.67	12.67	20.67	13.13	4.00	115.67	11.67	81.33	111.00	29.67	4.33	5.36	6.07	37.94
PSG 78	73.33	4.33	84.33	12.67	26.26	13.60	3.83	121.67	14.67	74.33	110.66	36.33	5.33	4.80	9.13	57.06
PSG 82	73.33	4.33	82.33	15.33	20.96	12.10	3.30	109.66	11.00	92.33	128.00	35.67	4.33	4.50	5.27	32.94
PSG 85	62.67	6.33	66.33	19.33	20.90	14.26	4.20	188.33	15.67	74.33	115.33	41.00	4.33	7.01	13.97	87.32
PSG 86	70.00	8.67	74.33	11.67	25.63	12.53	3.67	134.00	10.33	82.33	110.00	27.67	4.33	6.45	7.25	45.32
PSG 87	74.67	4.33	82.67	17.33	22.70	12.86	3.30	130.67	10.67	89.00	126.67	37.67	4.33	5.58	7.14	44.63
PSG 89	81.00	4.33	88.33	15.00	23.33	11.80	3.16	113.67	13.00	95.33	130.67	35.33	6.33	5.25	7.56	47.25
PSG 168	73.67	5.33	86.67	17.67	33.67	11.60	3.23	124.67	7.33	93.66	129.00	35.33	6.33	5.25	7.56	47.25
PSG 169	76.33	4.67	86.67	13.67	27.10	11.60	3.13	171.67	7.33	93.00	130.67	38.33	4.33	5.26	6.87	42.94
PSG 171	76.67	7.00	84.33	21.00	17.80	12.00	3.70	121.33	22.33	95.33	130.67	35.33	5.33	5.67	13.26	82.88
PSG 174	62.33	5.33	66.67	17.00	25.33	11.96	3.23	135.00	14.67	73.00	118.67	45.67	4.67	4.33	9.75	60.94
PSG 178	60.33	5.33	68.67	13.33	24.30	10.93	2.83	141.00	16.33	74.33	116.00	41.67	4.33	5.00	10.97	68.57
PSG 180	66.66	5.33	71.33	15.00	23.60	14.63	4.03	15.56	14.00	79.67	111.00	31.33	4.33	5.26	10.14	63.38
PSG 181	71.33	5.66	76.33	16.00	21.26	13.03	3.76	126.67	13.00	84.67	123.67	39.00	4.33	4.46	7.45	46.57
PSG 182	63.00	7.00	64.00	20.00	26.23	13.93	3.86	184.33	17.33	76.33	121.67	45.33	5.00	5.02	15.06	94.13
PSG 183	61.33	4.67	64.33	13.33	22.03	12.40	3.20	161.67	17.00	73.00	129.33	56.33	4.00	4.67	13.19	82.44
PSG 185	63.33	4.33	70.67	11.00	27.53	13.27	3.90	133.67	14.33	76.67	131.33	55.33	4.33	5.50	9.19	57.44
PSG 187	66.33	6.33	66.67	18.33	23.33	14.80	3.87	157.33	20.67	73.00	119.33	46.33	5.33	6.13	15.65	91.82
PSG 186	66.67	4.67	68.33	16.67	23.30	16.50	5.00	154.33	18.33	76.33	114.67	38.33	3.33	4.43	14.23	88.94
PSG 188	66.33	8.33	68.67	12.33	22.30	12.43	3.30	115.67	15.00	76.67	121.33	44.67	4.33	5.43	12.23	76.44
PSG 189	63.00	3.67	64.67	12.33	19.80	13.67	4.03	120.67	22.67	73.00	110.00	37.00	4.33	4.87	13.30	83.13

PSG 190	61.67	4.33	64.33	15.33	21.83	12.27	3.27	134.67	12.00	74.33	130.33	39.67	4.67	5.33	7.57	47.32
PSG 191	65.67	4.67	69.67	12.33	26.40	17.20	4.20	126.67	27.67	76.67	125.67	49.00	4.67	5.45	17.60	110.00
PSG 192	66.00	5.33	53.33	16.33	26.50	14.37	4.13	160.67	19.67	76.33	122.33	56.00	5.33	5.82	15.23	95.16
PSG 193	51.33	5.00	53.33	16.33	28.73	14.03	3.93	157.33	13.67	69.33	115.33	46.00	4.67	7.18	10.31	64.44
PSG 194	67.33	5.67	71.67	12.00	19.63	11.47	3.10	108.33	9.33	82.33	119.00	36.67	6.00	5.53	4.79	29.94
PSG 195	61.67	5.67	66.33	12.33	24.80	14.80	4.73	108.33	17.67	76.33	121.67	45.33	3.33	4.72	9.63	60.19
PSG 199	67.67	6.67	69.67	12.33	28.33	14.07	3.93	153.33	22.67	76.67	114.67	38.00	6.67	4.68	17.72	110.75
PSG 200	65.33	4.67	68.33	11.67	29.83	14.30	4.67	208.33	9.67	74.00	111.67	37.67	3.67	5.45	9.80	61.25
PSG 201	66.67	4.33	73.67	11.33	28.20	15.50	4.47	134.67	13.00	84.67	121.67	37.00	3.67	5.48	7.48	46.75
PSG 202	65.67	6.33	70.67	12.00	25.47	13.07	3.30	157.00	13.33	80.67	120.67	40.00	4.33	4.47	10.03	62.69
PSG 203	58.33	5.67	60.33	12.33	25.37	13.43	4.20	114.33	11.67	68.67	102.67	34.00	4.33	5.58	6.05	37.82
PSG 204	68.33	5.33	86.00	15.00	27.67	16.67	4.27	213.00	11.33	91.33	128.67	37.33	5.67	6.03	12.23	76.44
PSG 205	56.00	5.33	58.67	7.33	28.87	16.50	4.53	177.67	16.00	69.33	122.00	52.67	6.00	5.47	12.72	79.50
PSG 206	55.67	6.33	58.33	15.00	28.67	15.37	4.37	175.33	8.67	68.67	109.33	40.67	4.33	7.80	7.87	49.19
PSG 208	54.33	6.00	57.67	19.67	28.10	12.60	3.57	160.33	13.33	69.33	114.67	45.33	4.33	5.47	10.64	66.50
PSG 211	62.33	6.33	72.33	11.33	19.87	13.13	3.87	124.00	3.33	82.67	107.00	24.33	3.33	6.07	1.63	10.19
PSG 213	58.33	5.33	64.00	12.67	23.57	13.73	3.57	142.00	7.33	74.00	126.00	52.00	3.67	5.20	5.25	32.82
Mean	65.60	5.44	70.83	14.16	24.48	13.52	4.00	146.02	14.60	78.90	119.88	40.81	4.68	5.43	10.43	6519
Mean	51.33-	3.33-	53.33-	7.33-	17.80-	10.93-	2.83-	108.33-	3.33-	68.67-	102.67-	24.33-	3.33-	4.33-	1.63-	10.19-
Range	81.00	8.67	8.33	21.00	33.67	17.20	5.00	213.00	27.67	95.33	131.33	56.33	6.67	7.18	17.78	111.23
SEm ±	1.23	0.76	1.09	1.33	1.37	0.79	1.30	4.98	0.85	1.70	1.27	2.34	0.69	0.43	0.71	4.44
C.D.at 1%	4.59	2.82	4.08	4.97	5.10	2.97	4.87	18.57	3.16	6.34	4.73	8.73	2.58	1.63	2.63	16.44
C.D. at5%	3.97	2.13	3.08	3.76	3.86	2.25	3.68	14.05	2.39	4.80	3.58	6.61	1.95	1.23	1.99	12.44

Table 2. Mean performance of genotypes in rainy season

Geno-Types	Days to anthesis of 1st male flower	Node no. of 1st male flower	Days to anthesis of 1st female flower	Node no. of 1st female flower	Fruit length (cm)	Fruit peri-meter (cm)	Flesh thick-ness (cm)	Average fruit weight (g)	No. of fruits/ plant	Days to harvest 1st fruit fruit	Days to harvest last fruit	Duration of fruit harvest	No. of primary bran-ches	Vine length (m)	Fruit yield/ plot (kg)	Total yield (q/ha)
PSG 39	42.33	8.00	42.67	18.33	21.33	13.07	3.07	142.33	13.67	50.67	99.00	48.33	4.67	8.77	9.51	59.44
PSG 40	43.33	9.67	46.00	26.00	20.17	11.67	2.47	167.00	15.67	5000	99.00	49.00	7.67	10.03	12.17	76.06
PSG 50	45.00	11.00	46.34	24.67	20.10	13.30	3.06	179.33	16.67	50.67	99.00	48.33	6.67	5.72	13.74	85.88
PSG 59	43.67	9.61	45.67	25.00	21.33	12.10	2.80	121.33	15.00	50.00	98.33	48.33	5.00	8.73	8.81	55.06
PSG 61	40.33	9.00	44.00	26.67	20.10	13.37	3.23	146.00	15.33	50.00	99.00	49.00	5.33	7.33	12.20	76.25
PSG 62	47.33	11.33	51.33	17.67	19.50	11.87	3.20	142.00	6.00	50.67	99.00	48.33	4.67	9.12	4.41	27.56
PSG 65	42.67	8.00	45.67	27.67	24.97	12.30	2.81	158.67	15.67	50.00	98.33	48.33	6.00	9.30	12.25	76.56
PSG 170	43.33	8.67	44.33	27.00	23.03	11.93	2.80	150.00	18.67	50.67	97.67	47.00	8.33	9.12	14.61	91.31
PSG 71	44.33	12.00	44.67	27.33	19.60	11.77	2.93	148.00	10.33	50.00	97.67	47.67	5.33	8.80	8.06	50.38
PSG 74	46.67	12.33	47.67	30.33	21.80	12.47	3.17	154.00	16.33	50.67	99.00	47.67	4.67	8.03	12.51	78.19
PSG 75	44.33	11.00	45.67	24.67	17.17	12.40	3.20	164.33	16.67	50.67	99.00	48.33	6.33	10.85	13.28	83.00
PSG 78	44.67	12.33	45.00	26.67	20.13	11.13	2.87	171.67	12.00	50.00	98.33	48.33	7.67	8.48	9.44	59.00
PSG 82	43.67	11.67	46.67	22.67	24.00	12.06	3.13	170.67	13.33	50.00	98.33	48.33	7.00	9.23	10.92	68.25
PSG 85	43.67	14.67	46.33	25.67	20.17	12.90	3.67	166.67	14.33	50.67	99.00	48.33	8.00	11.33	12.48	78.00
PSG 86	46.33	15.33	49.67	30.33	17.27	11.87	2.83	117.67	16.33	50.67	99.00	48.33	8.33	9.38	8.94	55.88
PSG 87	45.33	15.00	48.67	12.67	19.20	13.10	3.20	152.33	13.33	50.67	98.33	47.67	8.00	8.57	9.76	61.00
PSG 89	43.00	10.33	43.33	18.33	17.13	11.73	2.80	147.67	15.00	50.67	98.33	47.67	6.33	8.27	10.11	63.19
PSG 168	42.00	10.67	46.67	27.67	22.47	11.33	2.80	182.00	13.67	50.00	98.33	48.33	7.67	8.83	12.74	79.33
PSG 169	45.33	8.67	48.33	28.33	23.17	12.40	2.93	163.00	14.00	51.33	99.00	47.67	7.67	7.30	10.46	65.37
PSG 171	44.33	10.33	45.00	28.33	20.20	13.63	3.23	144.33	16.00	50.00	98.33	48.33	7.00	9.87	11.70	73.13
PSG 174	42.33	8.33	44.00	25.67	21.27	11.80	2.87	157.66	16.33	50.67	99.00	48.33	8.00	9.13	12.27	76.69
PSG 178	43.33	8.33	44.33	20.33	23.57	12.13	3.13	161.67	13.67	50.67	99.00	48.33	6.67	7.68	10.41	65.06
PSG 180	44.67	11.33	46.00	22.33	19.50	12.93	3.23	155.67	16.33	50.00	98.33	48.33	9.67	9.78	12.30	76.88
PSG 181	41.67	13.33	42.33	23.67	21.23	11.63	2.96	180.00	15.33	50.67	99.00	48.33	6.00	9.30	12.90	80.63
PSG 182	44.00	8.67	45.67	17.67	19.83	13.10	3.37	132.33	17.33	50.00	98.33	48.33	5.67	1.05	10.71	66.94
PSG 183	41.33	11.33	43.33	24.67	22.23	13.53	3.60	130.00	15.33	50.67	99.00	48.33	6.00	7.95	10.36	64.75
PSG 185	43.33	11.67	46.67	21.33	21.80	12.47	3.03	127.00	13.67	50.00	98.33	48.33	8.00	8.93	9.02	5638
PSG 187	41.67	6.67	42.33	17.67	20.43	12.70	2.73	185.67	17.67	50.67	99.00	48.33	7.00	8.03	15.58	97.38
PSG 186	43.33	7.67	43.67	19.33	22.00	12.87	3.20	141.00	11.67	50.67	99.00	48.33	7.33	8.42	7.37	46.06
PG 188	45.00	10.33	46.00	24.33	24.53	14.27	3.27	134.67	14.67	50.67	99.00	47.67	6.67	9.18	9.56	59.75
PSG 189	41.67	9.00	43.67	24.66	17.60	13.60	3.73	171.67	7.67	50.67	98.33	48.33	6.00	7.28	6.85	42.81

PSG 190	43.33	10.22	46.00	24.67	20.30	11.70	2.83	144.00	9.33	50.67	98.33	47.67	5.67	6.92	6.31	39.44
PSG 191	42.67	9.00	43.33	18.33	20.17	11.87	3.13	168.67	13.33	50.67	99.00	48.33	7.33	7.78	10.37	64.81
PSG 192	41.00	8.33	44.00	25.67	17.70	11.63	2.80	178.33	16.33	50.00	98.33	48.33	6.00	8.63	13.90	86.88
PSG 193	41.33	9.67	43.67	23.33	21.67	12.50	2.80	156.67	11.67	50.67	99.00	48.33	7.67	10.33	8.67	54.06
PSG 194	43.33	11.33	40.67	27.00	18.83	10.80	2.93	110.67	11.30	50.67	99.00	48.33	6.00	8.65	5.97	37.31
PSG 195	40.67	7.67	42.33	19.00	21.13	12.57	3.37	156.00	20.67	50.67	99.00	48.33	5.67	8.45	16.23	101.44
PSG 199	43.33	8.33	46.33	27.67	21.17	10.50	2.87	182.67	20.33	50.67	98.33	47.67	7.00	7.83	18.31	114.44
PSG 200	44.33	8.67	45.67	21.67	20.60	12.03	3.03	166.67	15.67	50.67	99.00	48.33	4.33	8.13	12.58	78.62
PSG 201	45.67	10.33	46.33	25.33	22.73	11.40	3.06	151.67	15.00	50.67	99.00	48.33	6.33	10.10	11.46	71.62
PSG 202	43.33	9.00	44.00	21.00	21.13	11.87	3.10	113.67	16.33	50.67	99.00	48.33	6.67	8.18	8.84	55.25
PSG 203	42.00	9.33	43.00	19.33	23.87	10.37	2.93	145.33	12.33	50.33	98.33	48.33	7.33	8.25	8.60	53.75
PSG 204	42.67	7.67	43.67	18.00	21.10	11.87	3.10	159.33	11.33	50.67	98.33	47.67	5.00	6.33	8.33	52.06
PSG 205	40.67	7.33	42.67	20.67	20.37	12.83	3.40	125.33	16.33	50.67	97.67	47.00	6.00	7.23	9.74	60.88
PSG 206	41.67	8.33	43.00	21.00	18.30	12.90	3.17	148.33	11.67	50.00	97.67	47.67	4.33	7.22	8.54	53.38
PSG 208	47.67	9.67	47.67	26.33	20.33	12.40	3.40	141.33	10.67	50.67	97.67	47.00	6.67	9.63	7.67	47.94
PSG 211	46.67	11.67	45.67	17.67	18.87	11.20	3.03	126.33	14.33	50.00	98.33	48.33	6.33	8.45	9.46	59.13
PSG 213	42.33	10.67	44.67	24.00	21.87	10.90	2.83	145.67	17.67	50.00	98.33	48.33	5.33	9.07	12.83	80.19
Mean	43.47	10.08	45.09	23.24	20.77	12.22	3.06	151.87	14.42	50.44	98.60	48.14	6.52	8.62	10.70	66.88
Mean	40.33-	6.67-	40.67-	12.67-	17.13-	10.37-	2.47-	110.67-	6.00-	50.00-	97.67-	47.00-	4.33-	5.72-	4.41-	27.56-
Range	47.67	15.33	51.33	30.33	24.97	13.63	3.40	185.67	18.67	51.33	99.00	49.00	9.67	11.33	18.31	114.44
SEm ±	0.75	0.81	2.05	0.92	0.94	0.53	0.20	4.82	1.01	0.43	0.47	0.50	0.86	0.59	0.56	3.50
C.D.at 1%	3.11	3.34	7.65	3.42	3.50	1.97	0.74	17.94	3.73	1.63	1.76	1.87	3.21	2.21	2.07	12.94
C.D.at 5%	2.11	2.27	5.79	2.59	2.65	1.49	0.56	13.57	2.83	1.23	1.33	1.41	2.43	1.67	1.57	9.82

The genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), environmental coefficient of variation (ECV), heritability and genetic advance in per cent of mean were presented in Table 3. In the summer season, the high (> 30%) PCV was observed for flesh thickness (58.78%), fruit yield per plot (39.61%) and number of fruits per plant (35.16%) whereas, it was not found in the rainy season. Moderate PCV during summer season was recorded for node number of first male flower (28.96%), number of primary branches (27.34%), node of first male flower (24.29%), duration of fruit harvest (18.97%), average fruit weight (18.92%), vine length (17.53%) and fruit length (15.78%) while in rainy season moderate PCV was observed for fruit yield (26.77%), number of primary branches (26.26%), node number of first male flower (18.46%) and vine length (16.17%). PCV, less than 15% was observed for characters like fruit perimeter (13.60%), days to anethesis of first female flower (11.59%), days to anthesis of first male flower (9.26%), days to first fruit harvest (9.59%) and days to last fruit harvest (6.44%) in summer season while it was recorded for many characters in rainy season and the lowest PCV (0.82%) was recorded for days to last fruit harvest.

High GCV more than 30% for summer season was recorded for fruit yield per plot (37.82%) and number of fruits per plant (33.67), while in rainy season, it was absent for all the characters. In summer season the moderate GCV (15-30%) were recorded for average fruit weight (17.97%), node number of first female flower (17.94%), duration of fruit harvest (16.14%), node number of first female flower (16.05%) and flesh thickness (15.31 %) but in rainy season it was observed for fruit yield (25.14%), number of fruits per plant (18.97%), node number of first male flower (18.18%) and node number of first female flower (17.14%). Low GCV was observed for fruit length (12.45%), days to anthesis of first

Table 3. Estimates of variability, heritability and expected genetic advances in summer and rainy season

Character	Phenotypic coefficient of Variation (%)		Genotypic coefficient of variation (%)		Environmental coefficient of variation (%)		Heritability (%)		Genetic advance as mean (%)	
	Summer	rainy	Summer	Rainy	Summer	Rainy	Summer	rainy	Summer	Rainy
Days to anthesis of first male flower	9.618	4.761	9.047	3.699	3.264	2.996	88.4	60.3	17.53	5.92
Node no.of first male flower	28.957	22.853	16.048	18.183	24.102	13.843	30.7	63.3	18.30	29.79
Days to first female flower	11.591	7.916	11.277	0.602	2.679	7.890	94.6	0.5	22.60	0.09
Node no. of first female flower	24.294	18.457	17.938	17.142	16.384	6.841	54.5	86.2	27.28	32.79
Fruit length (cm)	15.786	11.149	12.446	7.948	9.710	7.818	62.1	50.8	2.22	11.67
Fruit perimeter (cm)	13.600	9.275	8.993	5.429	10.203	7.521	43.7	34.2	12.24	65.47
Flesh thickness (cm)	58.751	12.252	15.307	5.200	56.753	11.094	6.7	18.0	8.18	4.54
Average fruit weight(g)	18.922	13.304	17.973	12.115	5.917	5.499	90.2	82.9	35.17	22.73
Number of fruits/plant	35.157	22.504	33.670	18.968	10.115	12.110	91.7	71.0	66.41	32.93
Days to harvest first fruit	9.587	1.396	8.830	.518	3.734	1.490	84.8	13.7	16.75	0.40
Days to harvest last fruit	6.436	0.817	6.167	0.145	1.840	0.830	91.8	3.1	12.18	0.05
Duration of fruit harvest	18.969	1.733	16.142	0.532	9.962	1.813	72.4	9.4	28.30	0.34
No. of primary branches	27.338	26.263	9.608	12.793	25.594	22.937	12.3	23.7	6.94	12.84
Vine length (M)	17.525	16.168	10.728	1.813	13.857	12.019	37.4	44.7	13.52	14.90
Fruit yield/plot (kg)	39.615	26.716	37.820	25.136	11.788	9.052	91.1	88.5	139.90	118.12

female flower (11.28%), vine length (10.37%), number of primary branches (9.61%), days to anthesis of first male flower (9.05%), fruit perimeter (8.99%), days to first fruit harvest (8.83%) and days to last fruit harvest (6.16%) in summer season, while low GCV was found for many characters in rainy season and lowest GCV among all characters was 0.15% for days to last fruit harvest.

ECV recorded, high (> 30%) for summer season only for flesh thickness (56.55%) while it was absent for all the characters in rainy season. Moderate ECV (15-30%) in summer season was observed for number of primary branches (25.59%), node number of first male flower (24.10%) and node number of first female flower (16.38%) but in rainy season, moderate ECV was recorded only for number of primary branches (22.94%). ECV, less than 15%, was recorded for many characters of summer and rainy season. But, the lowest ECV was observed for days to last fruit harvest 1.84% and 0.83% in both summer and rainy seasons, respectively. There were no findings available on sponge gourd regarding genetic variability. However, the results were in conformity with those of other cucurbits like bitter gourd (Thakur *et al.* 1994) and ridge gourd (Khanikar *et al.*, 2002).

The heritability more than 80 per cent for summer season was recorded for days to anthesis of first female flower (94.6%), days to last fruit harvest (91.8%), number of fruits per plant (91.7%), fruit yield (91.1%), average fruit weight (90.2%), days to anthesis of first male flower (88.4%) and days to anthesis of first male flower (88.4%) and days to first fruit harvest (84.8%) while in rainy season more than 80% heritability was observed for fruit yield (88.5%), node number of first female flower (86.2%) and average fruit weight (82.9%). In the summer season, the moderate (50-80%) heritability was recorded for duration of fruit harvest (72.4%), fruit length (62.1%) and node number of first female flower (60.3%) and fruit length (50.8%). Length (less than 50%) heritability were recorded for five and eight characters during summer and rainy season, respectively. But the lowest heritability was recorded for flesh thickness (6.7%) in summer and days to anthesis of first female flower (0.5%) in rainy season. This is in accordance with work on different cucurbits like bitter gourd (Thakur *et.al.*, 1994) and pumpkin (Kumar *et al.*, 1997; Mohanty, 2000).

High genetic advance as per cent of mean (> 50%) during summer season was recorded for fruit yield (139.90%) and number of fruits per plant (66.41%) but in rainy season it was obtained for fruit yield (118.12%) and fruit perimeter (65.47%). In the summer season, the moderate (25-50%) genetic advances as percent of mean were recorded for average fruit weight (35.17%), duration of fruit harvest (28.30%) and node number of first female flower (27.28%) while, in rainy season, it was obtained for number of fruits per plant (32.93%), node number of first female flower (32.79%) and node number of first male flower (29.79%). Genetic advance as per cent of mean was found low (less than 25%) for ten characters in both the seasons. Number of primary branches, in summer season had the lowest genetic advance 6.94% while in rainy season. This is in accordance with work on different cucurbits like sponge gourd (Prasad *et al.*, 1984), ridge gourd (Sahni *et al.*, 1987 and Khanikar *et al.*, 1996) and pumpkin (Bindu *et al.*, 2000).

The characters like fruit yield and average fruit weight have high heritability coupled with high genetic advance in per cent of mean indicating that these traits were less influenced by environment and thus required low section intensity for improvement. This is in accordance with work on different cucurbits like sponge gourd (Panwar *et al.*, 1997; Prasad *et al.*, 1984), ridge gourd (Sahni *et al.*, 1987 and Khanikar *et al.*, 1996).

In general it was observed that not much variation was noticed for genetic parameters like GCV<PCV<heritability and genetic advance in per cent of mean among the characters during summer and rainy seasons. But the fruit yield performance of genotype was significantly differed during and rainy seasons, so that common genotypes may not be recommended for commercial cultivation during both seasons.

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ESTIMATES OF HETEROSIS FOR HORTICULTURE TRAITS IN BITTERGOURD

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ABSTRACT

Fifteen non reciprocal F1 hybrids derived from six diverse genotypes of bittergourd were evaluate in randomized block design (RBD) with three replications during summer 2000 to study heterosis over better parents and the check, Kalyanpur Barahmasi. Summing up the results on earliness, vegetative characters and yield and its components, the hybrids PBIG-2 X PBIG-1, PBIG-2 X Priya White and PBIG-1 X Kalyanpur Sona were found to be the most promising. Heterosis to the tune of 82.86%, 77.57% and 50.02% over the check were evidenced by these hybrids for yield per plant, respectively. Therefore, these hybrid deserve evaluations at multiplication and commercial exploitation.

Key words : Bittergourd, non reciprocal F_1 hybrids, better parental heterosis, check parent heterosis.

Bittergourd is one of the most nutritive and important cucurbitaceous vegetables grown throughout India as well as in Southeast Asian countries. The fruits are rich in several minerals and vitamins and have got medicinal properties too (Julia, 1967). Being monoceious in sex expression, it is highly cross-pollinated; which has resulted in variations in several qualitative and quantitative traits like fruit size, shape, number, weight and total yield in India. It is a well known fact that heterosis breeding is a quick, cheap and easy method of crop improvement in case of cross pollinated crops, one like bittergourd (Kolhe, 1972).

As mentioned above, a wide range of generic variability is available in our country, which envisages ample scope of its improvement through heterosis breeding (Ram *et al.*, 1997). Although, early workers have reported heterosis for yield and yield contributing characters in bittergourd, hardly any commercial; F1 hybrid has been released from public sector so far. It was therefore, felt necessary to make a beginning in this direction with a view to evolving high yielding quality F_1 hybrids through heterosis breeding.

MATERIALS AND METHODS

The materials comprised of 15 F_1 hybrids developed through half diallel mating system from six geographically diverse parental lines of bittergourd. The parental lines used were PBIG-2, PBIG-4, PBIG-1, Kalyanpur Sona, Kalyanpur Barahmasi and Priya White. All the 21 genotypes were evaluated in summer 2000 following randomized block design (RBD) with three replications. The seeds were sown in polythene bags, on February 29, 2000 and were kept under plastic house. Transplanting in the field was done on April 1, 2000, maintaining a spacing of 2.0 x 0.75 m. Care was taken to do the gap filling within seven days of transplanting. Data were taken on five random plants excluding the border plants on individual plants basis. The nine traits studied were days to first female flowering, nodal position of first female flower, main vine length (m), number of primary branches per plant, fruit length (cm), fruit diameter (cm), fruit weight (g), number of fruits per plant and fruit yield per plant (g), heterosis was estimated as percentage deviation of the F1 mean over better parent (heterobeltiosis) and check cultivar, Kalyanpur Barahjmasi (standard heterosis) for each cross for all the traits and their significance was tested by 't-test'.

RESULTS AND DISCUSSION

The mean square estimates were significant for all the characters studied indicating sufficient genetic diversity among the genotypes. Estimates of heterosis of the hybrids were calculated over their respective better parent and the standard check, Kalyanpur Barahmasi. In cucurbits, including bittergourd days to first female flower anthesis and its nodal position are indices of earliness (Khattara *et al.*, 1994; Ram *et al.*, 1997). Importance of earliness is well recognized keeping in view of high market prices. Several crosses such as PBIG-2 X Kalyanpur Sona (-29.51%), Kalyanpur Sona X Priya White (-16.24%) and PBIG-4 X Priya White (-14.50%) showed highly significant negative heterosis.

Table 1. Analysis of variance for various horticultural traits of bittergourd (summer 2000)

Source of variation	D.f.	Days to first female flower anthesis	Nodal position of first female flower	Vine length (m)	No. of primary branches per plant	Fruit length (cm)	Fruit dia. (cm)	Fruit weight (g)	No. of fruits per plant	Fruit yield per plant (g)
GCA	2	5.58	2.35	0.06	0.95	1.95	0.07	8.86	20.70	628.44
SCA	21	46.24**	12.39**	0.46**	30.59**	36.84**	0.72**	263.41**	180.16**	9760.2*
Error	40	4.38	1.53	0.03	1.91	0.89	0.02	8.32	9.82	443.82
CV (5%)		4.65	14.25	5.21	6.38	5.3	3.9	4.86	13.38	14.93

* : Significant at 5% level of significance

** : Significant at 1% level of significance

Table 2. Mean value of parents and crosses for different horticultural traits of bittergourd (summer 2000)

Parents Variation female	Days to first of first flower anthesis	Nodal position (m) female flower	Vine length branches	No. of primary (cm) per plant	Fruit length (cm)	Fruit dia. (g)	Fruit weight plant	No. of fruits per (g)	Fruit yield per plant
PBIG-2	42.40	7.82	3.08	3.27	14.12	3.27	46.92	14.11	663.23
PBIG-4	48.28	5.58	3.27	3.32	15.63	3.32	72.92	31.33	2281.12
PBIG-1	42.91	8.23	3.45	3.19	16.32	3.19	65.21	29.27	1648.25
K.S.	42.90	7.45	2.22	2.97	11.15	2.97	53.38	16.97	909.47
K.B.	49.54	12.50	3.27	2.36	17.16	2.36	50.10	20.33	1400.33
P.W.	53.75	11.91	3.48	3.76	18.98	3.76	69.39	23.00	1596.66
PBIG-2 X PBIG-4	46.57	8.94	3.16	4.22	19.26	4.22	74.06	20.38	1507.91
PBIG-2 X PBIG-1	42.63	7.93	3.14	3.91	16.81	3.91	74.92	34.16	2560.65
PBIG-2 X K.S.	34.92	7.44	2.27	3.60	13.50	3.60	50.27	28.18	1417.19
PBIG-2 X K.B.	50.28	11.09	3.83	3.16	17.11	3.15	66.17	29.88	1977.26
PBIG-2 X P.W.	52.78	9.76	3.10	3.71	18.16	3.71	72.39	34.30	1486.65
PBIG-4 X PBIG-1	45.16	4.58	3.38	3.92	18.16	3.92	66.57	13.05	871.99
PBIG-4 X K.S.	44.64	10.20	3.17	3.17	18.54	3.17	52.69	29.57	1544.75
PBIG-4 X K.B.	45.64	8.15	3.31	4.38	17.76	4.38	63.03	23.16	1459.09
PBIG-4 X P.W.	42.58	8.53	3.55	3.29	16.16	3.29	64.29	31.58	2030.47
PBIG-1X K.S.	44.09	7.57	3.19	3.07	18.65	3.07	71.20	29.50	2100.49
PBIG-1X K.B.	43.46	7.50	3.75	4.24	23.23	4.24	54.23	14.65	795.05
PBIG-1X P.W.	49.16	8.27	3.39	3.40	18.57	3.40	50.61	11.86	598.50
K.S. X K.B.	46.67	7.13	3.43	3.07	19.43	3.07	66.43	19.69	1316.22
K.S. X P.W.	41.49	9.05	3.24	3.43	18.22	3.43	49.06	11.77	575.63
K.B. X P.W.	44.18	9.34	3.54	3.75	15.15	3.75	59.59	17.21	1028.92

Table 3. Estimates of heterobeltiosis and standard heterosis of bittergourd hybrids for different horticultural traits (summer 2000)

Hyb -rids	Days to first female flower anthesis		Nodal position of first female Flower		Vine length (m)		No. of primary branches per plant		Fruit length (cm)		Fruit diameter (cm)		Fruit weight (g)		No. of fruits per plant		Fruit yield per plant (g)	
	Heterobe ltiosis	Std. Het.	Heterobe-ltiosis	Std. Het.	Heterobe-ltiosis	Std. Het.	Heterobe-ltiosis	Std. Het.	Heterobe-ltiosis	Std. Het	Heterobe-Ltiosis	Std. Het.	Heterobe-ltiosis	Std. Het.	Heterobe-ltiosis	Std. Het.	Heterobe-ltiosis	Std. Het.
1x2	9.8*	-5.9	42.3**	-5.13	-3.5	-3.5	-32.0**	3.9	23.2	29.1*	27.0**	79.0**	1.6	47.8**	-35.0**	0.3	-33.8**	7.7
1x3	0.5	-13.9**	1.4	-36.9**	-9.1*	-4.1	-41.1**	-10.0	3.0	-38.1**	19.5**	66.0**	33.3*	49.5**	16.7	68.1**	55.8**	829**
1x4	-17.6**	-29.5**	-0.2	-41.0**	-26.2**	-30.6**	-13.6**	32.1**	-4.4	-50,3**	10,1**	52.8**	-5.8	0.3	-66.1**	38.6**	55.8**	1.2
1x5	16.8**	1.5	41.7**	-11.9	17.0**	17.0**	-30.1**	7.0	-37.0**	-37.1**	-3.9	33.5**	32.1**	32.1**	47.0**	47.0**	41.2**	41.2**
1x6	0.9	-13.6**	24.8*	-22.4*	-11.1**	-5.4	-28.9**	8.7	-4.3	33.2**	1.2	57.5**	4.3	44.5**	49.1**	68.7**	55.7**	77.6**
2x3	5.4	-8.8**	-17.9	-63.6*	-2.0	3.3	-12.6	-0.8	11.3	-33.2**	18.0**	66.2**	-8.7*	32.9**	-58.3**	-35.8**	-61.7**	-37.7**
2x4	4.1	-9.9**	82.8**	-19.0*	-3.1	-3.7	-23.7**	-2.6	18.6*	-31.8**	-4.5	34.6**	-27.7**	5.1	-6.5	44.0**	-32.3**	10.3
2x5	-5.5	-7.9**	46.2**	-35.2**	1.2	1.2	-1.9	11.3	-34.6**	-34.7**	31.9**	85.9**	-13.6**	25.8**	-26.1**	14.0**	-36.0**	4.2
2x6	-11.8**	14.1**	52.9**	32.2**	2.1	8.5*	-21.0**	-0.4	14.8	-40.5**	-1.1	39.4**	-29.0**	28.3**	0.8	55.4**	-10.9	45.0**
3x4	2.9	-11.0**	1.6	-39.8**	7.4	-2.4	-7.5	18.2**	18.6*	-31.3**	4.0	30.1**	4.3	42.1**	0.7	45.1**	27.4*	50.0**
3x5	1.4	-12.3**	-8.8	-40.4**	8.6*	14.4**	-19.3**	-9.6	-7.2	-7.1	32.6**	79.7**	-3.5	8.3	-50.0**	-28.0**	-51.7**	-43.2**
3x6	14.5**	-0.9	0.5	-34.3**	-2.6	3.6	-20.6**	0.0	-2.16	-31.7	-9.4**	44.4**	-27.1	1.0	-59.5**	-41.6**	-63.7**	-57.3**
4x5	8.8*	-5.8	-4.4	-43.4**	4.8	4.8	-7.5	18.2**	28.46**	-24.5**	3.4	30.7**	24.4**	32.6**	-3.1	-3.2	-7.6	-6.0
4x6	-3.3	16.2**	21.4	-28.1**	-7.1	-1.1	-13.4**	9.1	-4.0	-33.0**	8.8**	45.3**	-29.3**	-2.1	-048.8**	-42.1	-63.9**	-58.9**
5x6	-10.8	-10.8**	-21.5*	-25.7**	1.5	8.0	14.5**	44.3**	-44.2**	-44.2*	0.2	59.1**	-14.1**	19.0**	-25.1**	-15.3**	-35.6**	-26.5**

This crosses PBIG-2 X Kalyanpur Sona (-17.64%) and PBIG-4 X Priya White (-11.82%) also showed significant negative heterosis over their better parents. While for nodal position of first female flower PBIG-4 X PBIG-1 (63.59%), Kalyanpur Sona X Kalyanpur Barahmasi (-43.36%) and PBIG-2 X Kalyanpur Sona (-40.87%) exhibited significant negative standard heterosis. It is noteworthy here that the negative values for the above two characters are an indication of earliness. The best hybrids for yield per plant viz. PBIG-2 X PBIG-1, PBIG-2 X Priya White and PBIG-1 X Kayanpur Sona also showed earliness for days to first female flower anthesis and its nodal position, satisfying the basic assumption of production of hybrids.

There has been a positive association between number of branches per plant and number of fruits per plant in all the cucurbits including bittergourd (Srivastava and Srivastava, 1976; Fredrick and Staub, 1989). This implies that more the number of laterals per plant more would be the yield per plant. In this experiment the most heterotic hybrid for main vine length was PBIG-2 X Kalyanpur Barahmasi (16.98 and 16.98%) followed by PBIG-1 X Kalyanpur Barahmasi (14.43 and 8.60%) in terms of standard heterosis and heterobeltiosis, respectively. As regards number of primary branches per plant the best two hybrids were Kalyanpur Barahmai X Priya White (44.28%), PBIG-2 X Kalyanpur Sona (32.05%).

Fruit appearance, which is largely determined by its length, diameter and colour, has profound effect on total yield as well as consumer acceptance. Out of the 15 hybrids, only two *viz.*, Kalyanpur Sona X Kalyanpur Barahmi (28.446%) and PBIG-2 X PBIG-4 (23.20%) exhibited significantly positive heterosis over their better parents, while non was at par than the standards check. For fruit diameter the best hybrids was PBIG-4 X Kalyanpur Barahmasi (85.88 and 31.86%) followed by PBIG-1 X Kalyanpur Barahmasi (79.67 and 32.64%) and PBIG-2 X PBIG-4 (78.95 and 26.95%) in terms of standard heterosis and heterobeltiosis, respectively.

Any breeding programme including heterosis breeding would not be regarded as successful unless the developed variety outperforms the existing varieties in terms of yield. Fruit weight and number of fruits per plants determines the yield to a greater extent in bittergourd. PBIG-2 X PBIG-1 came out to be the best performing hybrid, which recorded 82.86% higher yield over the check Kalyanpur Barahmasi and 55.44% over the better parent. It also exhibited standard heterosis and heterobeltiosis for fruit weight (49.55 and 33.28%) and number of fruits per plant (68.04 and 16.70%), respectively. PBIG-2 X Priya White was adjudged as the second best, which recorded 77.57% standard heterosis and 55.74% heterobeltiosis for yield per plant, 44.50% standard heterosis for fruit weight and 68.72 and 49.13% standard heterosis and heterobeltiosis, respectively for number of fruits per plant. Other hybrds, which showed significant heterosis for yield, were PBIG-1 X Kalyanpur Sona (50.02% standard heterosis) and PBIG-2 X Kalyanpur Sona (55.83% heterobeltiosis). Presence of heterosis for yield contributing characters in bittergourd have also been reported by Khattara et al. (1994); Mishra *et al.* (1995); Celine and Sirohi (1996) and Ram *et al.* (1997).

In bittergourd it is the marketable yield rather than total yield rather, which matters to fetch a good price in the market. In the present investigation one of the interesting results was that almost all the best performing hybrids produced significantly higher number of fruits per plant with higher average fruit weight accompanied with earliness to flowering, signifying the utility of hybrids from farmer's point of view. In the present investigation three hybrids namely PBIG-2 X PBIG-1, PBIG-2 X Priya White and PBIG-1 X Kalyanpur Sona was found to be the best heterotic combinations in the yield and most of the other yield contributing traits. Therefore, the hybrids may be worth exploiting through heterosis breeding and may also be recommended for commercial cultivation by the farmers after some additional multilocation trials repeated over years.

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EFFECT OF WATER-NITROGEN INTERACTION ON GROWTH, YIELD, NITROGEN USE EFFICIENCY AND WATER USE EFFICIENCY OF RICE (*ORYZA SATIVA*)

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ABSTRACT

Effect of water, nitrogen and farmyard manure (FYM) application and their interactions on the growth, yield, nitrogen use efficiency (NUF) and water use efficiency (WUF) of two rice genotypes namely, Pusa Basmati 1 and Proagro 6111, under puddled transplanted conditions were assessed in a Typic Haplustept silty clay loam soil for two years (1999 and 2000). The treatments consisted of three water regimes and six nitrogen (N) treatments during 1999 and eight N treatments during 2000 with different combination of fertilizer N and FYM. Maximum growth and development as well as grain yield was observed in N_{150} under continuous submergence treatment in both the seasons. However, substitution of 50 per cent of N through FYM resulted in reduction in growth and development. Partitioning of dry matter in different crop growth stages varied significantly in different water regimes and N treatments. WUE increased and NUE decreased with increasing N rate. Water regimes had significant effect on WUE and NUE. Path analysis results indicated that leaf area index and plant biomass were the two most important characters for increasing grain yield. Regression models have been developed to predict the interaction of nitrogen and water on grain yield.

Key words : Nitrogen and water interactions, grain yield, dry matter partitioning, NUE, WUE, path coefficients and regression analysis.

Rice is the staple food of nearly half of the world's population an to cope up with the growing population, an extra 65 per cent of rice has to be produced by 2025 (Tuong *et al.* 1996). Water and fertilizer are the two inputs, which have contributed significantly in obtaining higher productivity in all crops including rice. However, continuous rice cropping has often resulted in declining or stagnant yields raising concerns about long-term sustainability of rice cultivation. Therefore, to sustain or enhance the present rice productivity, it is essential to develop measures to increase the use efficiency of these two inputs.

Eighty percent of the total fresh water is used for irrigation and almost half of that is consumed by rice alone. The declining rate of per capita fresh water availability necessitates production of rice with limited water using alternate management options, which can increase the use efficiency of water and reduce its losses. Though continuous submergence results in higher grain yield of rice in the short term, it reduces the use efficiency of both applied water and fertilizer N. Percolation loss of water as high as 1850 mm, has been reported during the whole rice season under submerged conditions (Abedin *et al.* 1991). Tuong *et al.* (1996) reported bypass losses to the extent of 41 percent of the applied water. Similarly application of fertilizer nitrogen in the form of urea on standing water is subjected to severe losses (Rao *et al.* 1985).

Among different fertilizers, nitrogen (N) contributes the maximum in enhancing rice production. However, the use efficiency of fertilizer N is very low due to it's rapid mineralization and losses through different pathways before it is utilized by the crop (Bhattacharya and Singh, 1992) and it is estimated to be only 30-40% in rice (De Datta and Buresh, 1989). The rest of N is lost through denitrification, volatilization, leaching, runoff and immobilization (Norman *et al.* 1992). Water management in addition to integrated N management can enhance N use efficiency. As reported by Sarvanan *et al.* (1987), farm yard manure (FYM) and green manures are sources of nitrogen which when used in conjunction with urea, increases the efficiency of applied nitrogen. Addition of FYM was considered essential for protecting nutrient loss through leaching in rainfed low land rice soil (Wade and Ladha, 1995). The use efficiency of water and fertilizer N requires proper management of both inputs. Studies on water and N management separately are plenty in number, however, literature on the quantification of their interaction is meager. The present study was, therefore, undertaken to assess the effect of water and N interaction and FYM application (substituting a fraction of N dose) on growth, yield and N uptake by rice crop.

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MATERIALS AND METHODS

Field experiments were conducted during the *kharif* (monsoon) seasons of 1999 and 2000 in the research farm of Indian Agricultural Research Institute, New Delhi (28°38'N and 72°10'E). The soil is classified as Typic Haplustept. It is silty clay loam in texture with a pH of 7.83, average bulk density 1.45 Mg m^{-3}, hydraulic conductivity of 0.45 cm h^{-1} and average organic carbon content of 0.45 per cent. Climate is semi arid type with a mean annual temperature of 25°C and average rainfall of 650 mm during rainy season.

The experiment was laid out as a spit plot design with water regimes as main plots and nutrient levels as subplot treatments. The main plot treatments were : I_c (continuous submergence), I_1 and I_3 (irrigation one day and three days after disappearance of standing water, respectively). The subplot treatments were : N_0, N_{90}, N_{120}, N_{150}, N_{120F}, and N_{150F} (subscripted numbers denote the amount of N in kg/ha and subscripted F denotes 50% of that amount was applied through FYM and 50% through urea). During 2000 along with these treatments, two more N treatments (N_{90} and N_{90F}) were applied. Each treatment was replicated thrice. Size of each plot was 5.75 m x 4.25 m.

Twenty-five day old seedlings of the rice variety Pusa Basmati 1 were transplanted on 22nd July 1999 at a spacing of 20 x 15 cm. The crop was harvested on 15th November. During 2000, rice hybrid Proagro 6111 was grown. Twenty-one day old seedlings were transplanted on 26th July in this season and the crop was harvested on 3rd November. Nitrogenous fertilizer was applied as per the treatment requirement. For applying N through FYM the nitrogen content of the applied FYM was estimated. It was found to be 0.5 per cent. Accordingly, the amount of FYM required to supply the required amount of N was calculated. Fifty per cent of the required urea nitrogen along with whole FYM and recommended dose of P and K (60-80 kg ha^{-1}, respectively) were applied before transplanting. Rest 50 per cent of required urea N was applied in two equal splits, one at maximum tillering stage and next at panicle emergence stage. Irrigation was given as per the treatment. Amount of water applied was monitored by installing Parshall flumes (in first year) and by water meter (in second year). In order to maintain treatment-wise soil water regimes, each plot was separated from the other by placing thick plastic sheets along the bunds up to 45 cm. This prevented lateral flow between the plots.

Dry matter partitioning was carried out at different growth stages (tillering, panicle, and flowering) and grain yield was recorded at harvest. Correlation and path analysis were carried out to know the degree and nature of association of different factors on yield using standard techniques. Multiple regression analysis was carried out for quantifying the effect of water-nitrogen interaction on grain yield.

Nitrogen use efficiency was calculated as kg of grain yield per kg N applied. Water use efficiency was calculated as kg of grain produce per cm of water used as evapotranspiration (ET). ET was estimated by deducting both percolation loss and soil moisture storage from applied water. Standing water of 7 cm was monitored by putting one scale in each plot. The amount of water required to maintain 7 cm standing water was measured. Soil moisture content at 4 depths i.e., 0-15, 15-30, 30-60 and 60-90 cm was determined before and after irrigation gravimetrically in non flooded plots to find out the soil moisture storage. Percolation loss of water below the crop root zone was monitored during submergence period with the help of periodical depletion of water level, maintained in PVC cylindrical pipe (20 cm diameter and 30 cm depth) installed at the center of each plot. Evaporation loss was deducted to get the actual percolation value.

All the parameters were analyzed statistically by applying the technique of analysis of variance and the significance was tested by 'F' test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Total biomass and partitioning into different plant parts

At each growth stage, the dry weight of each component increased with increasing N dose. At the same N level, the dry weight of each component was highest under I_c water regimes as compared to I_1 and I_3. Addition of FYM to substitute 50 per cent of inorganic fertilizer resulted in reduction in dry weight at all the stages. At tillering, panicle emergence and flowering stage, stem contributed maximum percentage to the total biomass. Accumulation of dry matter in grain increased with days after flowering and with N dose in Pusa Basmati 1. At physiological maturity stage under I_c water regime, proportion of grain weight was about 44% of total biomass in N_0 treatment to about 48% in N_{150}. A similar trend was observed in the other two water regimes also. However, in Proagro 6111 the proportion of dry matter in grain varied from 28 to 35 per cent among different N treatments in I_c water regime. At harvest, the total biomass increased with each successive increase in N level up to 150 kg ha^{-1} in both varieties (Table 1). Averaging across water regimes, biomass increased from 7.89 Mg ha^{-1} in N_0 treatment to 10.4 Mg ha^{-1} in N_{150} in Pusa Basmati 1 and from 12.38 to 19.26 Mg ha^{-1} in Proargo 6111. Averaging across N treatments, biomass increased from 8.48 Mg ha^{-1} in I_3 to 8.99 Mg ha^{-1} in I_1 to 9.58 Mg ha^{-1} in I_c in Pusa Basmati 1 and from 14.84 Mg ha^{-1} in I_3 to 15.56 Mg ha^{-1} in I_1 and to 17.14 Mg ha^{-1} in I_c in Proagro 6111. Effect of water regime on biomass was significant at lower N levels (up to N_{120}). At N_{150}, it was statistically at par in all the three water regimes during both 1999 and 2000.

Table 1. Biomass, grain yield and harvest index of Pusa Basmati 1 and Proagro 6111 as influenced by N and water treatments

	Biomass (Mg ha^{-1})			Grain yield (Mg ha^{-1})			Harvest index		
N Treatments	I_c	I_1	I_3	I_c	I_1	I_3	I_c	I_1	I_3
				Pusa Basmati 1					
N_0	8.72	7.75	7.21	3.91	3.26	2.84	0.45	0.42	0.39
N_{60}	9.26	8.22	7.98	4.22	3.58	3.10	0.46	0.44	0.39
N_{120}	9.88	9.81	8.75	4.60	4.33	4.06	0.47	0.44	0.46
N_{150}	10.15	10.12	9.85	4.84	4.80	4.43	0.48	0.47	0.45
N_{120F}	9.54	8.72	8.03	4.25	3.78	3.39	0.45	0.43	0.42
N_{150F}	9.92	9.29	9.04	4.50	3.99	3.85	0.45	0.43	0.43
				Proagro 6111					
N_0	12.71	12.60	11.82	4.11	3.69	3.60	0.32	0.29	0.30
N_{60}	15.68	13.97	13.81	5.28	4.67	4.63	0.34	0.33	0.34
N_{90}	17.78	14.85	14.62	5.57	5.25	5.02	0.31	0.35	0.34
N_{120}	18.81	16.72	15.43	5.89	5.91	5.18	0.31	0.35	0.34
N_{150}	20.39	19.35	18.04	6.53	6.40	5.73	0.32	0.33	0.32
N_{90F}	13.97	13.09	12.35	4.48	4.24	4.05	0.32	0.32	0.33
N_{120F}	17.43	15.72	15.51	5.39	5.08	4.70	0.31	0.32	0.30
N_{150F}	20.36	18.17	17.17	6.50	6.26	5.72	0.32	0.34	0.33

N being an important constituent of bimolecules such as protein and nucleic acids, plays an important role in influencing plant growth and development through better utilization of photosynthates which in turn helps to increase the total biomass at harvest. The beneficial effect of nitrogen fertilization in increasing total biomass of rice has been reported by many researchers (Sakal, 2000; Patra *et al.* 2000). The reduction in growth parameters by substituting 50 per cent of N through FYM is due to reduced availability of nutrients in the initial crop growth stages, as nutrients added through FYM are locked up and released into the soil gradually creating a suboptimal condition for the crop. Soil moisture stress as a single factor is know to limit plant growth and development in all crops. Cabangon *et al.* (2001) reported 1-7% higher yields in continuous flooding than AWD. Iqbal (2004) also reported positive effect of flooding in increasing biomass and grain yield due to reduced weed growth.

Grain yield

Grain yield increased with each successive increase in N level up to 150 kg ha^{-1} (Table 1) Among the three water regimes, grain yield was highest under I_c, which was significantly higher as compared to I_3, but was at par statistically with I_1 in both the years (Table 1). Averaging across water regimes, it varied from 3.34 Mg ha^{-1} in N_0 to 4.69 Mg ha^{-1} in N_{150} during 1999 (Pusa Basmati 1) and from 3.80 to 6.22 Mg ha^{-1} during 2000 (Proagro 6111). The response to N application was more for the hybrid variety Proagro 6111 than Pusa Basmati 1. The response was significant up to 150 kg N for Proagro 6111 in all the three water regimes. In Pusa Basmati 1 except for I_3 water regime, increase in yield was not significant beyond N_{120}. Increase in grain yield with increase in N rate is due to increased photosynthetic efficiency of crop leading to production of more number of spikes per square meter, more number of grains per spike and also increase in thousand seed weight. Positive effects of increasing N levels on grain yield of rice were reported by Channabassappa *et al.* (1998) and Singh and Singh (2000). Among water regimes, grain yield was greatest in I_c and lowest in I_3. Averaging across N treatments, it increased from 3.61 (in I_3) to 4.39 (in I_c) during 1999 and from 4.83 (in I_3) to 5.43 Mg ha^{-1} (in I_c) during 2000. Higher grain yield under continuous submergence may be because of optimum soil water regime, which enabled the plant to absorb more nutrients. Continuous submergence also reduced weed problems (Balasubramanian and Krishnarajan, 2001). Favourable effect of continuous submergence on grain yield was reported by Timsina *et al.* (1998). Increase in grain yield and biomass with increase in N rate was more pronounced under I_c. Similar observation was found by Iqbal (2004). Substitution of 50 per cent of inorganic fertilizer by FYM resulted in reduction in grain yield (Table 1). For Pusa Basmati 1 in N_{120} treatment, the grain yield was 4.33 Mg ha^{-1} (average of three water regimes) as compared to 3.83 Mg ha^{-1} in N_{120F}. The difference was observed for N_{150} treatment also. Similarly for Proagro 6111, the grain yield in N_{90}, N_{120} and N_{150} treatments were greater than that in N_{90F}, N_{120F}, N_{150F} treatments, respectively (Table 1). It may be due to reduced availability of nutrients, as nutrients added through FYM are locked up and released into the soil gradually creating a sub optimal condition for the crop within short period.

Harvest index of Pusa Basmati 1 was found to be more as compared to Proagro 6111 (Table 1). In case of Pusa Basmati 1, the harvest index varied from around 44 to 48% while for Proagro 6111, it varied from 31 to 34%. Lower harvest index in case of hybrid variety Proagro 6111 may be due to higher LAI and vegetative growth with a relatively low grain-filling rate. In case of Pusa Basmati 1, the harvest index was high (>40%). Harvest index of about 47% for Pusa Basmati 1 was reported by Prakash *et al.* (2002).

Path coefficient analysis

Path coefficient analysis results indicated that grain yield was positively correlated with number of tillers per m^2, LAI, number of spikes, number of grains per spike, number of grains per m^2, thousand seed weight and total plant biomass. During 1999 (Pusa Basmati 1), the direct contribution of LAI was highest followed by biomass, number of tillers and number of grains

Table 2. Results of path analysis for Pusa Basmati 1 and Proagro 6111

Variables	No. of tillers per m²	No. of spikes per m²	No. of grains per spike	No. of grains per m²	1000 seed weight (g)	LAI	Biomass
			Pusa Basmati 1				
No. of tillers per m²	0.4916	-0.2142	-0.6519	0.3031	-0.168	0.5893	0.451
No. of spikes per m²	0.4507	-0.2336	-0.05638	0.2919	-0.1716	0.5429	0.4082
No. of grains per spike	0.4336	-0.1782	-0.739	0.3054	-0.1491	0.5494	0.3419
No. of grains per m²	0.4091	-0.1873	-0.6197	0.3642	-0.1972	0.59	0.4133
1000 seed weight (g)	0.3819	-0.1855	-0.5098	0.3323	-0.2162	0.5489	0.3843
LAI	0.4515	-0.1977	-0.6905	0.3349	-0.185	0.6416	0.3948
Biomass	0.4043	-0.1739	0.4608	0.2745	-0.1515	0.4619	0.584
			Proagro 6111				
No. of tillers per m²	-0.0612	0.1753	-0.0977	-0.0247	-0.0902	0.119	0.6656
No. of spikes per²	-0.0506	0.2121	-0.0569	-0.0248	-0.1135	0.1233	0.7367
No. of grains per spike	-0.0314	0.1296	-0.0931	-0.0166	-0.1224	0.1093	0.6863
No. of grains per m²	-0.0381	0.13324	-0.0389	-0.0396	-0.041	0.1132	0.7153
1000 seed weight (g)	-0.0361	0.1573	-0.0745	-0.0106	-0.1531	0.1071	0.6471
LAI	-0.0474	0.181	-0.0704	-0.031	-0.1134	0.1445	0.8442
Biomass	-0.0447	0.1714	-0.0701	-0.0311	-0.1087	0.1338	0.9115

per m² on grain yield. Negative association with number of spikes, number of grains per spike and thousand seed weight was observed. Residual effect was found to be 0.132 (Table 2). During 2000 (Proagro 6111), a negative association was found between grain yield and tiller number, number of grains/spike, number of grains per m² and thousand seed weight. Contribution of biomass to yield was found to be the maximum followed by number of spike per m² and LAI. Residual effect was found to be very low *i.e.*, 0.0523 (Table 2). Low residual effect indicated that the characters chosen for path analysis were adequate and appropriate. The path analysis results obtained in this present study were in agreement with the findings of Ram (1992) and Kannan Babu and Soundrapandian (1993) for the number of productive tillers per square meter; Ram (1992), for the number of filled grains per panicle; those of Mehetre *et al.* (1994) and Surek and Beser (2003) for biomass.

Water use efficiency and Nitrogen use efficiency

Nitrogen use efficiency was lowest under N_{150} treatment in all water regimes. For both of the varieties, NUE was highest in I_c treatment followed by I_1 and lowest in I_3 water regimes (Table 3). Pirmoradian *et al.* (2004) observed that high (continuous flood irrigation) applied water decreased N-use efficiency for rice as compared to intermittent irrigation (2 days interval).

WUE has highest in I_3 water regime in all the nitrogen treatments during both the seasons. It was lowest under I_c water treatment except at low N levels (N_0 and N_{60}) during 1999. The difference in WUE was less between I_c and I_1 than between I_1 and I_3. The WUE increased with increase in N dose and was highest in N_{150} treatment in both the seasons (Table 3). Increase in WUE with increase in N levels is in accordance with the earlier reports of Muntajabuddin and Borulkar (1983) and Kalita and Sarmah (1992). Won *et al.* (2003) reported that the water use efficiency, increased by 44% in very shallow intermittent irrigation and 26% in shallow intermittent irrigation when compared with deep water irrigation.

Prediction of yield by multiple regression models

Grain yield was the dependent variable

Table 3. Nitrogen use efficiency and water use efficiency as affected by N treatments and water regimes

N Treatments	NUE (kg grain/kg N applied)			WUE (kg grain/cm water applied)		
	I_c	I_1	I_3	I_c	I_1	I_3
			Pusa Basmati 1			
N_0	***	***	***	3.01	3.15	4.19
N_{60}	70.29	51.64	59.72	3.24	3.44	4.59
N_{120}	38.32	33.83	36.09	3.54	4.51	5.54
N_{150}	32.28	29.53	32.00	3.72	4.92	6.13
			Proagro 6111			
N_0	***	***	***	2.69	2.90	4.32
N_{60}	87.95	77.77	77.13	3.41	3.64	5.36
N_{90}	61.92	58.28	55.77	3.66	4.13	6.03
N_{120}	49.09	49.28	43.17	3.81	4.65	6.23
N_{150}	43.34	41.74	38.10	4.11	4.87	6.87

while nitrogen applied (N), water applied (W) and their combinations, namely, N*W, N^2, W^2, N^2*W,W^2*N, were chosen as independent variables. Stepwise regression for Pusa Basmati 1 indicated that among the above independent variables, N^2 was the most important factor influencing the grain yield. The response function estimated for grain yield as a function of N^2 was :

$$Y(1) = 33.874 + 6.024\ E\text{-}04N^2\ (R^2= 0.698) \ldots\ldots(1)$$

For Proagro 6111, N*W was found to be the most important single factor influencing the grain yield. The response function estimated for yield taking that single parameter was :

$$Y(1) = 39.353 + 1.184\ E\text{-}04\ N{*}W\ (R^2=0.946)\ldots\ldots(2)$$

The prediction of grain yield by the regression model was improved by using N, W ad N*W as the independent variables. The R^2 value for Pusa Basmati-1 increased to 0.797 and for Proagro 6111 to 0.978. By adding W^2 as another independent variable to the above three variables, the prediction was found to be the best for both the varieties. The equation of best fit for each variety is given below.

For Pusa Basmati 1:

$$Y(2) = 125.245 + 0.192N\text{-}0.209W\text{-}1.0E\text{-}04N{*}W + 1.123\ E\text{-}04W^2(R^2=0.95)\ldots\ldots\ldots\ldots \quad (3)$$

For Proagro 6111:

$$Y(2) = 36.735 + 0.124N\text{-}4.92E\text{-}03W{+}2.435E\text{-}05\ N{*}W{+}4.990E\text{-}06W^2(R^2=0.98)\ldots\ldots\ldots\ldots \quad (4)$$

From these above results, we may conclude that for hybrid rice in silty clay loam soil, the recommended dose (120 kg ha^{-1}) of N may be increased to 150 kg/ha. As the economic grain yield for I_c and I_1 are significantly at par, I_1 water regime may be adopted for rice cultivation to increase water use efficiency and save water. From the regression equations developed, it is possible to work out the precise combinations of nitrogen and water required as inputs for a specific yield level of rice. Yield prediction in rice wil be better when N, W, N*W and N^2 are used as independent variables.

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EFFECT OF WEED MANAGEMENT PRACTICES ON WEED DENSITY AND YIELD OF BOLD SEEDED LENTIL

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Weeds, being a serious negative factor in crop production are responsible for reduction in the yield of lentil to a tune of 84 per cent (Mohamed *et al.* 1997). For control of weeds, several methods have been tried in the past with varying degree of success, which include hand weeding, hoeing, intercropping and use of herbicides. An integrated approach involving cultural method in combination with chemical provides more economical and environmental friendly method of weed control. A little work has been done with regard to weed control on recently developed bold seeded varieties of lentil. In the light of above, the present investigation was undertaken.

A field experiment was carried out at the Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar during *rabi* season of 2000-01. The experimental plot was silty clay loam in texture having organic carbon 0.7%, available N 297.6 kg/ha, available P 26.7 kg/ha and available K 196.0 kg/ha with soil pH of 7.2. Ten treatments (Table 1) were laid out in randomized block design with four replications. The bold seeded variety 'DPL 58' was sown in rows, 23 cm apart, using seed rate of 50 kg/ha on 14 November 2000. Herbicides were sprayed as per treatment using 1000 litre water/ha. The crop was fertilized uniformly with 50 kg DAP/ha applied as basal. During crop period site experienced a rainfall of 44.2 mm. Weed samples were collected, dried and subjected to logarithmic transformation (x+1) before statistical analysis.

Pendimethalin @ 0.75 kg/ha (pre-emergence) + one hand weeding at 45 DAS reduced weed density significantly as compared to other treatments. The next in order were isoproturon @ 0.75 kg/ha (pre-emergence) + one hand weeding at 45 DAS and 25% higher seed rate + one hand weeding at 30 DAS and one hand weeding at 30 DAS. Less weed density under these treatments might be due to complete removal of weeds by hand weeding and smothering effect of crop on late germinated weeds. Faroda and Singh (1981) also reported the same on weeds in lentil.

One hand weeding at 30 DAS recorded significantly higher values of growth parameters *viz.* number of branches per plant and dry matter accumulation per plant, as compared to remaining treatments except weed free. Lower weed density as well as mechanical manipulation of soil at optimum crop growth time might have created congenial environment for horizontal growth and development of crop which ultimately reflected on yield attributes *viz.* pods per plant and grains per pod. There was no significant variation in plant height and 1000-grain weight due to various weed control treatments (Table 1).

Weed free, 25% higher seed rate + one hand weeding at 30 DAS and one hand weeding at 30 DAS, being on par produced 34, 24 and 19% higher grain yield respectively over weedy check. Higher values of yield attributes and lower weed density are mainly responsible for increased grain yield under weed free and one hand weeding at 30 DAS. Increased plant density and early weed control measure under 25% higher seed rate + one hand weeding at 30 DAS smothered the weeds and compensated lower values free situation. Kumar and Kolar (1989) also reported an increased response of lentil to hand weeding in comparison to herbicide application.

Table 1. Effect of Weed control practices on weed density, crop growth parameters, yield attributes and yield of crop

Treatment	Weed density (plants/0.25 m^2) at 90 DAS	Plant height at harvest (cm)	Number of branches/ plant at harvest	Dry matter accumulation at harvest (g/plant)	Pods/ plant	Grains/ pod	1000-grain weight (g)	Grain yield (kg/ha)
Iso @ 1.0 kg/ha (PE)	3.16(22.8)*	32.93	21.5	7.734	80.3	1.28	31.48	2025
Iso @0.75 kg/ha(PE)+One HW-45DAS	1.66(4.3)	33.50	24.6	9.187	85.7	1.33	32.15	2178
Iso @ 1.0 kg/ha (POE)	3.49(3, 1.8)	32.65	20.4	7.083	79.2	1.27	31.10	2005
Pend. @ 1.0 kg/ha (PE)	3.04(20.3)	33.25	22.2	8.676	84.6	1.28	31.60	2166
Pend @ 0.75 kg/ha(PE)+One HW-45DAS	1.31(2.8)	33.60	25.5	10.379	86.3	1.35	32.48	2194
25% higher SR	3.57(34.8)	43.80	14.0	6.117	52.1	1.10	29.30	1965
25% higher SR + One HW - 30 DAS	2.41(10.3)	37.73	16.1	7.355	66.3	1.16	30.85	2339
One HW - 30 DAS	2.52(11.5)	34.22	27.0	10.790	87.8	1.36	34.08	2251
Weed free	0.00(0.0)	35.49	28.6	11.675	91.3	1.50	34.58	2520
Weedy check	3.62(36.8)	31.08	17.9	6.882	76.1	1.25	31.00	1892
SEm ±	0.05	3.56	0.5	0.112	3.6	0.06	1.27	93
CD at 5%	0.15	NS	01.5	0.325	10.5	0.19	NS	272

Iso = Isoproturon, Pend : = Pendimethalin; DAS = Days after sowing; PE = Pre-emergence; POE = Post.emergence
HW = Hand weeding; SR = seed rate; NS = Non-significant
*Original values are in paranthesis

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EFFECT OF BIO-FERTILIZER (*AZOLLA PINNATA*) ON HEAVY METALS IN SOILS OF LUCKNOW DISTRICT

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Excessive use of chemical fertilizers have wasted thousands of hectares of land in India and create a number of pollution problems whereas bio-fertilizers have a number of advantages over chemical fertilizers, these are very cheap, production method is very simple and it create no pollution problems. They supply other nutrients, may control plant pathogens, also supply vitamins and plant growth hormones and prevent soil erosion by producing capsular polysaccharides; they also convert immobilized chemical fertilizers into soluble forms and make them available to the plants, reported by Deshmukh (1998).

Oes (1913) observed that Kjeldahl analysis of the azolla indicated a nitrogen increase equivalent to 369 microgram nitrogen/day dry weight over a period of 11 weeks. Smith (1938) reported that sporophyte of azolla consists of a floating rhizome with small, altemate, overlapping leaves, in cavities of leaves of azolla, anabaena (blue-green alga) is present, which are helpful in nitrogen fixation. Singh and Chauhan (2002) studied the effect of organic manures on soil productivity of hills of Uttaranchal and found that soil properties also improved under organic nutrition. Singh *et al.* (2002) also studied the effect of green manuring and bio-fertilizers in relation to fertilizer nitrogen on yield.

Prakash and Bhadauria (2002) reported that organic manure can influenced the crop tolerate to pathogens and pests in rice. According to Das *et al.* (1995), bio-fertilizer like azolla, BGA etc. are important nitrogen sources in rice cultivation and bio-fertilizer may bring about changes in the availability of different micronutrients like Zn, Fe, Mn and Cu in soils. Srivastava and Tondon (1951) suggested that azolla act as green manure for many crops, mainly in rice cultivation. Saubert (1949) considered that the nitrogen fixing ability of azolla was its major attraction as a green manure crop. Approximately 310 kg N/ha would be assimilated in one year by a single layer of the plants, applying azolla as a green manure, high concentration of heavy metals (Cu and Cd) decreases chlorophyll content and nitrogen fixation activity of azolla. Copper is less toxic then cadmium for azolla, reported by. Gangopadhyay and Santra (1996). Diara *et al.* (1987) also reported that azolla, along with anabaena azollae considered as an efficient bio-fertilizer. Duhan and Singh (2002) studied the effect of different green manures and find out that they are helpful in nitrogen fixation, control the concentration of heavy metals (Zn, Fe, Cu and Mn) and also improve the soil health.

The present investigation was conducted in various sites of Lucknow district, including each 8 block, in different seasons. The soil samples were collected from all 8 blocks in interval of 3 months during July 2001 to April 2002. Samples were taken from cultivated area of 4 villages of each 8 blocks. Samples were brought to laboratory in polythene bags for analysis and spread out on thick brown paper; coarse, concretion, stones and pieces of roots, leaves and other under composed organic residue were removed. Large lumps of moist so were broken by hands. Soil samples were air dried for 24 hours. These samples crushed gently in pestle and mortar through 2 mm sieve. Sieved soil samples extracted with DTPA solution. The soil extract used for analysis of Zn, Fe, Mn, Cu and B through atomic absorption spectrophotometer method (Allen *et al.* 1986).

In our investigation, out of 32 only 20 sampling sites are selected from each seasons during July 2001 to April 2002 in 3 month regular interval, which were highly polluted with heavy metals like Zn, Fe, Cu, Mn and B. All sites show that concentration of selected heavy metals decreases when sufficient amount of selected bio-fertilizer (azolla) added on these sites. For preparation of mass cultivation of azolla, micro plots selected, in which water is added for proper growth of azolla. Suitable amount of P_2O_5/ha also added. Optimum pH (8.0) and temperature (14-30°C) is maintained. Finally micro plots are inoculated with fresh azolla (0.5-0.4 kg/m^2).

The values of concentration of heavy metals obtained were presented in Table 1. pH show alkaline (7.1-8.4) nature of soil. Without azolla, concentration of zinc is maximum (9 ppm) in Bakhsi ka talab, in July 2001. Iron show maximum concentration value (126.8 ppm) in chinhat, also in July 2001. Copper show excess (6.1 ppm) in kakori again in July 2001. Excess of manganese (73 ppm) reported in gosaiganj in January 2002. Boron show high value (13.1 ppm) in Mohanalalganj in October 2001. According to Allen *et al.* (1986), if concentration of Zn, Fe, Mn, Cu and B are greater than 1.2 , 8.0 , 4.0, 0.4 and 0.5 ppm respectively, considered as polluted. Thus these concentration acts as standard for selected heavy metals.

On applying azolla in selected soil samples, concentration of Zn decreases from 9 to 6 ppm, Fe from 126.8 to 60.2 ppm, Mn from 73 to 60 ppm, Cu from 6.1 to 2.2 ppm, and B from 13.1 to 4.0 ppm. On highly polluted and toxic sites, by application of selected bio-fertilizer (azolla pinnata) the concentration of almost all heavy metals decreases. According to Singh (1979), azolla shows tolerance against heavy metals like As, Hg, Zn, Fe, Cu, B and Cd etc, so it act as excellent fertilizer in the soils polluted due to metal wastes. Application to chemical sources such as Zn SO_4 (22% Zn), ZnO (80% Zn),

Table 1. Comparative assessment of heavy metals in selected study sites (Lucknow district during July 2001 to April 2002)

Month	Block	Element	pH	Concentration without azolla (ppm)	Concentration with azolla (ppm)
July, 2001	BKT	Zn	8.3	9	6
	CHIN	Fe	7.7	126.8	60.2
	KK	Mn	8.2	72.2	40.3
	KK	Cu	8.1	6.1	2.2
	MLB	B	8.4	2.2	1.5
October, 2001	GG	Zn	7.1	5	4
	CHIN	Fe	7.5	52	41
	BKT	Mn	8.2	29.2	21
	CHIN	Cu	7.5	3	2.1
	MLG	B	8.1	13.1	4
January, 2002	BKT	Zn	7.1	4.4	4
	MALL	Fe	7.9	118.5	88.1
	GG	Mn	8.2	73	60
	GG	Cu	8.1	4.3	2.4
	GG	B	7.9	5	3.5
April, 2002	MLB	Zn	7.8	3	2
	GG	Fe	7.7	124.2	80.1
	MLG	Mn	8.2	64	31
	CHIN	Cu	8.3	4.6	2
	MALL	B	8.0	2.5	2

BKT-Bakhshi ka talab
CHIN-Chinhat
MLB-Malihabad
MLG-Mohanlalganj
GG-Gosaiganj
KK-Kakori

Zn dust (99% Zn) and Zn-EDTA (14% Zn) increases the concentration of Zn in soils, reported by Takker (1996). Excess of Fe due to use of large amount of chemical fertilizer as a sourceof Fe such as $FeSO_4$, Fe-EDTA, Pyrites, suggested by Bear (1995). Chemicals like MnO_2, $MnSO_4$, Mn_2O_3, act as fertilizers also and increases concentration of Mn, reported by Nayyar *et al.* (1990). Excess use of Borax ($Na_2B_4O_7$) also increases concentration of Boron, studied by Takker *et al.* (1997). Das *et al.* (1995) determined that introduction of azolla, decreases the extractible Fe and Mn content in soil as compared to that in the uninoculated one (no azolla). The essence of life in the soil is in its crop producing capacity *i.e.*, the soil productivity. Soil fertility is that component of productivity which primarily deals with nutrient supplying capacity of soil to the plant. These nutrients and their concentration can be increased by application of microbial fertilizers in place of chemical fertilizers.

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PERFORMANCE OF TWELVE ACCESSIONS OF *CAJANUS PLATYCARPUS* (BENTH.) VAN DER MAESEN

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Cajanus platycarpus (Benth.) Van der Maesen, (2n=22) (Pundir and Singh, 1986), an Indian wild species belonging to tertiary gene pool of pigeonpea occurs in grassy habitats. Seed size (approx. 6gm/100 seeds) of *C. platycarpus* was quite attractive in domestication of pigeonpea as a crop. It is an annual species but perennates under favourable conditions. *C. platycarpus* is known for early maturity, annuality, high pod set, large seed size, resistance to Fusarium wilt caused by *Fusarium udum* Butler and *Phytophthora* blight caused by *Phytophthora drechsleri* Tucker f. sp. Cajani. Maesen, 1990). Accession ICP 15665 (ICPW 064 ; JM 4350) flowered in 44-48 days, with pods setting in 69-73 DAS and was ready to harvest in 124-168 DAS in 2001., at IARI, New Delhi under screenhouse conditions. It is being maintained by Division of Genetics, IARI, New Delhi. Present study has revealed that the plats of *C. platycarpus* are erect/spreading type. Leaves are ovate with acute tip and pubescent lower leaf surface. Pods are 2-6 seeded, light green and flat. Seeds are dark purple, globular shaped with wide seed eye width and large strophiole. Growing period is from end of may to first week of December.

Present study is based on performance of twelve accessions of *C. platycarpus* at IARI, New Delhi in 2002 and 2003 with an aim to outline their growing and flowering period for successful utilization as one of the donor parents in interspecific hybridization with existing cultivated varieties in order to incorporate useful genes for disease/s resistance and other desirable traits.

Twelve accessions of *C. platycarpus* available at ICRISAT, Patancheru, were screened under screen house conditions in pots containing soil + FYM + sand in the ration of 2:1:1 in RBD (Randomized Block Design) in 3 replications for various parameters such as seed germination, flowering, pod setting, maturity as per descriptors (1993), pollen fertility/viability, disease resistance and insect pest/s (pod borer and pod fly) resistance (Table 1). Data were collected on five plants per replication. Simple staining method using dilute solution (2%) of acetocarmine was attempted for a quick check

Table 1. Twelve accessions of *C. platycarpus* obtained from ICRISAT, Patancheru, A.P.

S. No.	Accession No.	Identity	Origin
1.	ICP 15661	JM 2873	India
2.	ICP 15662	JM 2989	India
3.	ICP 15663	JM 3310	India
4.	ICP 15664	JM 4297	India
5.	ICP 15666	PR 4550-1	India
6.	ICP 15667	PR4557	India
7.	ICP 15668	PR 4572	India
8.	ICP 15669	ICPW 068(JR collection)	India
9.	ICP 15670	ICPW 069	India
10.	ICP 15671	ICPW 070 (Kasabad collection)	India
11.	ICP 15672	ICPW 071 ; W 4351	India
12.	ICP 15673	ICPW 072 ; No. 222	India

Table 2. Performance of twelve accessions of *C. platycarpus* at IARI, New Delhi under screenhouse conditions in 2002-03

S.No.	Accession No.	Seed germination (%) (7 DAS)	Field establishment (%)	Flowering (%) (36 DAS to 44 DAS)	Pod setting (%)		Pollen viability	
					44 DAS	78 DAS	Fertile pollen (%)	Sterile pollen (%)
1	ICP 15661	26.66±11.54*	40.00±0.00*	66.66	33.33	100.00	100.00±0.00*	0.00±0.00
2.	ICP 15662	29.99±4.71	33.33±11.54	60.00	33.33	100.00	100.00±0.00	0.00±0.00
3.	ICP 15663	80.00±0.00	73.33±11.54	100.00	80.00	100.00	98.66±1.31	1.33±1.33*
4.	ICP 15664	40.00±34.64	60.00±31.62	80.00	16.66	100.00	98.63±0.68	1.36±1.04
5.	ICP 15666	66.66±11.54	60.00±0.00	100.00	16.66	100.00	82.33±0.50	17.65±0.65
6.	ICP 15667	49.99±4.71	73.33±13.32	100.00	12.50	100.00	55.55±5.55	44.44±5.54
7.	ICP 15668	60.00±20.00	60.00±0.00	100.00	100.00	100.00	94.37±0.56	5.61±0.54
8.	ICP 15669	53.33±21.08	66.66±11.54	62.50	100.00	100.00	73.93±11.23	26.06±11.24
9.	ICP 15670	73.33±11.54	66.66±11.54	75.00	25.00	100.00	94.93±0.39	5.06±0.39
10.	ICP 15671	46.66±23.09	40.00±20.00	66.66	0.00	37.50	100.00±0.00	0.00±0.00
11.	ICP 15672	33.33±2.09	33.33±11.54	100.00	25.00	75.50	99.65±0.32	0.34±0.34
12.	ICP 15673	20.00±0.00	20.00±0.00	50.00	0.00	50.00	88.92±0.69	11.01±0.97

*Mean ± SD of 3 replications

of pollen viability. Empty pollen grains (sterile) fail to stain owing to absence of cytoplasm (Kaul and Singh, 1969). Fertile stained pollen grains accounted for pollen viability. Response to Fusarium wilt was scored based on any visible symptoms of disease (Nene *et al.*, 1981). Insect pest (Pod borer and pod fly) resistance was scored based on pods damage and scored on 1-9 susceptibility scale (Reed and Lateef, 1990). Plant protection measures in the form of fungicide and insecticide for Fusarium wilt and insect pest/s damage were not adopted under screen house conditions.

Plants (50 per cent and above) of twelve accessions (Table 2) flowered in 36-44 DAS with pod setting in 44 DAS (ICP 15668, ICP 15669) in 2002 and ready to harvest in 78-83 DAS, suggesting uniform ripening and maturity. Low to intermediate pod setting was observed in ICP 15673 in 78 DAS. Simple staining method using dilute solution (2%) of acetocermine was used as a quick check for pollen viability. Fertilie stained pollen grains accounting for pollen viability were found to be more than 70 per cent (except in ICP 15667) in eleven accessions of *C. platycarpus* (Table 2) suggesting high to very high pollen fertility. No. pod damage due to pod borer/pod fly, neither any wilt symptoms due to Fusarium udum were observed in any of the twelve accessions of *C. platycarpus*, suggesting pod borer/pod fly resistance and Fusarium wilt resistance which are to be further confirmed by artificial screening.

Present study on performance of twelve accessions of *C. platycarpus* in 2002-2003 and compared with ICP 15665 being maintained since 2001, has outlined the growing period of this wild species from end of May to first week of December under Delhi conditions (Table 3). Flowering period is from September to October, which with adjustable time of sowing coincides with the flowering period of cv Pusa 33 of pigeonpea, at IARI, New Delhi. Ten accessions of *C. platycarpus* exhibited uniform ripening and early maturity (except ICP 15671 and 15671 and 15673). High pollen fertility (except in ICP 15667) in eleven accessions has identified this species as one of the donor parents in interspecific hybridization with existing cultivated varieties

Table 3. Growing period of ICP 15665 (ICPW 0.64 ; JM 4350) and twelve accessions of *C. platycarpus* under screenhouse conditions, in 2001-03

S. No.	Accession/s	Date of Sowing	Date of harvest	Growing period	
				Days	Duration
1.	ICP 15665 (ICPW 0.64; JM 4350)	22.5.01	5.11.01	168	End of May to first week of November
2.	Twelve accessions	11.9.02	3.12.02	84	Second week of September to first week of December
3.	Twelve accessions	28.7.03	6.11.03	102	End of July to first week of November

of pigeonpea for introduction of useful characters viz., early maturity, annuality and multiple disease resistance. Interspecific pollination between *C. platycarpus* and pigeonpea can be further increased by application of 50 ppm GA3 or kinetin (Dhanju and Gill, 1985). Further studies are to be concerted on generation of interspecific hybrids utilising various accessions of *C. platycarpus* for incorporation of genes of importance.

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